Effects of Audiovisual Distraction During Dental Prophylaxis

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ABSTRACT

Background. Fear and anxiety often inhibit patients from seeking dental care. Audiovisual, or A/V, distraction techniques have been shown to reduce patient anxiety and pain during dental procedures. The authors investigated the effects of a virtual image A/V eyeglass system on patients' anxiety and pain.

Methods. Twenty-seven routine dental prophylaxis patients participated and completed the Dental Fear Survey and the Fear of Pain Questionnaire-III before treatment. In random order, the clinician scaled and polished two quadrants in subjects while they watched and listened to a standard video using the A/V eyeglasses and two quadrants while they did not. A posttreatment questionnaire was administered to both the patient and the clinician.

Results. Subjects reported less anxiety and discomfort when using the A/V eyeglass system than when they did not. Most subjects preferred to use the A/V equipment rather than receive traditional treatment. The clinician experienced no significant technical interference during the use of the A/V device. The use of the A/V eyeglasses led to decreased treatment time in the first one-half of the procedure. The system appeared to lead to some decreases in the physiological parameters over the course of treatment, with the highest systolic blood pressure occurring after the condition with no use of A/V eyeglasses.

Conclusions. A virtual image A/V system is beneficial in the reduction of fear, pain and procedure time for most dental prophylaxis patients.

Clinical Implications. Use of screening questionnaires may be helpful for identifying anxious patients. An A/V device may be beneficial to the clinician and the mildly or moderately anxious patient.

Despite advances in dental technologies and treatment, many people still avoid or delay dental care because of fear and anxiety.[1] Although effective behavioral and pharmacological treatments exist for high levels of dental fear and phobia, avoidance continues to be a public health problem.[2] Dental anxiety has been associated with poor oral health status, as measured clinically and by self-assessment.[1] The growing knowledge base about the implications of periodontal disease as a possible risk factor for cardiovascular disease,[3] diabetes mellitus,[4] respiratory disease[5] and preterm low–birthweight infants[6] makes dental avoidance behavior more problematic.

All of the subjects who completed this study said they would prefer to use the audiovisual eyeglasses again during dental procedures.

While the degree of treatment invasiveness and the seriousness of disease have implications for the dental anxiety level, problems still exist even in routine care. De Jongh and Stouthard[7] found that most patients reported that treatment provided by a dental hygienist caused as much as or more anticipated, actual and residual anxiety than did other dental treatment. It was hypothesized that since local anesthetic typically is not used for dental hygiene treatment, the decrease in patients' anxiety owing to the less invasive nature of the treatment may be offset by the lack of pharmacological intervention.

A number of methodologies have been developed to help assess dental anxiety and fear. Dental fear has been measured with questionnaires such as the Dental Anxiety Scale[8] and Dental Fear Survey, or DFS,[9-11] as well as the Dental Fear Interview.[12] While there are numerous self-report instruments that measure various aspects of the sensory, affective and evaluative components of pain, only a few tools have been developed that directly assess fear and anx-

Figure 1. The virtual image audiovisual eyeglass system used in the study.

iety associated with pain.[13] One of these, the Fear of Pain Questionnaire-III, or FPQ-III, is a 30-item instrument that measures pain-related fear in a traitlike fashion, so there are no assumptions about prior pain experiences.[13,14] It has demonstrated utility in dental behavioral science research[15] and predictive ability in terms of actual avoidance behavior.[13]

Behavioral methods for dealing with a patient's stress and pain have become increasingly more commonplace in dentistry. Patient distraction often has been studied as a means of alleviating anxiety and pain.[16] Comparing three distraction techniques for reducing stress in patients, Seyrek and colleagues[17] found that video techniques were more effective than an audio program. Results further suggested that successful distraction was accompanied by an increase in physiological arousal, possibly indicating the degree of psychological absorption or engagement in the video.

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Several virtual reality audiovisual, or A/V, systems (Figure 1) have been marketed that may be more beneficial than earlier systems.[18] In contrast to the traditional A/V program that uses a large television monitor above the patient's chair, this system includes a lightweight, goggle-style eyeglass system that has a built-in television monitor (two 0.7-inch full-color liquid crystal displays with 138,000 pixels per panel) along with stereo earphones. Systems such as these have been found in laboratory tests to be effective in reducing pain in adults.[19] Moreover, use of this methodology has been demonstrated to lower the pulse rates of children undergoing dental treatment.[20] Similarly, Satoh and colleagues[21] found that this A/V eyeglass system decreased adult patients' anxiety while they were undergoing scaling.

We conducted this study to evaluate the effects of a contemporary personal A/V eyeglass system on patients' reported anxiety level, pain level and appointment length. It was hypothesized that use of the A/V eyeglasses would decrease anxiety and discomfort (pain) in a majority of patients, would be successfully implemented in their dental prophylaxis and would lead to decreased time required for treatment.

METHODS AND MATERIALS

Patients. We recruited adult patients for the study on a voluntary basis as they reported for their dental hygiene appointment at the West Virginia University School of Dentistry faculty practice. Thirteen men and 14 women 18 years of age and older were enrolled after the dental hygienist provider (C.L.F.) reviewed their medical histories and they signed an informed consent statement. Patients not accepted into the study included those with a history of seizures or convulsive disorders, nystagmus, vertigo or equilibrium disorders, and those taking psychotropic drugs. The mean age for this sample was 44.3 years (± 20.2 standard deviation, or SD). All of the subjects were Caucasian except for one who was African-American. Of these patients, 41 percent (n = 11) had been seen previously by the treating dental hygienist. The mean length of time since the last recall was 19.0 months (± 19.3 SD).

Psychometric instruments. Patients completed the DFS and FPQ-III. The DFS is a 20-item, Likert-type (1-5 scale) verbal report instrument used to assess dental fear.[9-11] The survey provides a total dental fear score, as well as a variety of subscale scores assessing anticipatory anxiety, fear reactions to situations encountered routinely during restorative dentistry and reported physiological responses to dental procedures.

The FPQ-III is a 30-item, Likert-type (1-5) scale verbal report instrument. It approaches

measurement of pain-related fear with the assumption that fear is specific to particular stimuli and context. Consistent with this premise, it includes a variety of types of pain and painful stimuli, including, but not limited to, assessing fear of dental and medical procedures, severe pain situations and minor painful events.[13-15]

A posttreatment questionnaire (Figure 2) was designed by the investigators to assess patient treatment preference and effects of the A/V eyeglasses. This patient questionnaire was a 7-item Likert-type (1-7 scale) verbal report instrument with items reflecting appointment anxiety, discomfort (pain) and perceived procedure duration. Also, the treating clinician answered two questions at the completion of appointment. One asked for the hygienist's perception of the subject's level of ease during treatment while using the A/V device compared with the level of ease during treatment without use of the device. The second asked if the A/V eyeglasses interfered with the dental hygienist's ability to perform the required needed clinical procedures.

POSTTREATMENT A/V QUESTIONNAIRE

(Circle the number most appropriate)

Subject:

1. Did the portion of your appointment using the A/V glasses seem _____ ?

Shorter			Same			Longer
1	2	3	4	5	6	7

2. Were you more or less anxious during your dental treatment when using the A/V glasses?

Less			Same			More
1	2	3	4	5	6	7

3. During your appointment, how did the discomfort (pain) level seem with the A/V glasses?

Less			Same			More
1	2	3	4	5	6	7

4. Do you prefer having dental procedures performed with the A/V glasses or without?

Without			No Difference			With
1	2	3	4	5	6	7

5. How enjoyable did you find watching the video during your appointment?

Not at All			Moderately Enjoyable			Very Enjoyable
1	2	3	4	5	6	7

6. How immersed in the video did you get?

Not at All			Moderately Immersed			Very Immersed
1	2	3	4	5	6	7

Provider:

1. Did the subject seem more at ease with or without the A/V glasses?

With			No Difference			Without
1	2	3	4	5	6	7

2. Did the A/V glasses interfere with your ability to perform the required procedures?

Yes			Somewhat			No
1	2	3	4	5	6	7

Figure 2. Posttreatment A/V Questionnaire.

Design. This experiment used a randomized mixed factorial design. Factors were order (that is, either use of A/V eyeglasses first followed by the non use of A/V condition or the reverse) to which patients were randomly assigned and condition (that is, either use of A/V eyeglasses or nonuse of A/V eyeglasses), which was a repeated measure. Dependent variables included self-report questionnaires and ratings, time spent completing the prophylaxis and physiological measures (that is, pulse rate, systolic and diastolic blood pressures, and respiration rate). For the physiological measures only, the condition factor also included a baseline measurement.

Procedure. Before we began treatment, the patient completed the DFS and FPQ-III. We also recorded demographic information, the date of the patient's last prophylaxis and the number of previous prophylaxis appointments with the clinician. The clinician performed supra- and subgingival sonic scaling and handscaling with polishing as indicated on one-half of the mouth, without the use of anesthetic, while the patient used the A/V eyeglasses system. Scaling and polishing of the other one-half of the dentition was performed without the use of the A/V eyeglasses system or anesthetic. A coin toss was used to randomly determine which side of the dentition was to be treated initially and whether the A/V eyeglass system would be used for the first or second portion of the treatment. As two patients withdrew from the study, 13 subjects used the A/V eyeglasses during the first one-half of treatment, and 12 used the A/V eyeglasses during the second portion.

A product demonstration video without a plot that showed various scenic and activity segments in three dimensions was viewed by all patients. Relatively equal numbers of teeth were present in

TABLE 1

MEANS, STANDARD DEVIATIONS AND RESULTS OF *t*-TESTS COMPARING USE OF AUDIOVISUAL EYEGLASSES VS. NONUSE OF A/V EYEGLASSES.

QUESTION	MEAN	± STANDARD DEVIATION	*t*	*P* VALUE
Subject				
1. Length of appointment*	2.9	1.5	3.86	.001
2. Anxiety level during treatment*	2.7	1.0	6.41	.001
3. Discomfort (Pain)*	2.5	1.1	6.59	.001
4. Preference*	5.2	1.8	3.29	.003
5. Video enjoyable†	4.8	1.5	12.88	.001
6. How immersed in video?†	4.8	1.7	10.03	.001
Provider				
1. Subject seemed more at ease using A/V system*	3.2	1.3	3.02	.006
2. A/V system interfered with procedures	6.0	1.2	20.41	.001

* A rating of "4" was the comparison value for the one-sample *t*-test.
† A rating of "1" was the comparison value for the one-sample *t*-test.

the two portions of treatment, and all treatment was provided by a dental hygienist (C.L.F.). We measured blood pressure and heart rate using a digital electronic blood pressure monitor before treatment was begun, after the first one-half of treatment and after the second one-half of treatment.

After treatment of both halves of the mouth was completed, the subject completed the posttreatment patient questionnaire, and the dental hygienist independently responded to the two clinician questions.

RESULTS

Sample size analysis and description of statistical analyses. To identify the sample size needed to adequately test for statistical differences, we conducted an analysis based on χ^2 tests, which were the principal analyses for determining the success of the intervention. With 27 subjects, an anticipated "large" effect size[22] and 1 degree of freedom, the power exceeded 0.70, which was acceptable. In terms of other analyses, we used one-sample *t*-tests to evaluate possible differences in ratings from a neutral point (either a rating of "4" or a rating of "1"). For the factorial-based variables, we conducted analyses of variance, or ANOVAs, with follow-up Tukey's Honestly Significant Difference, or HSD, tests at the 0.05 level. We conducted zero-order correlations, comparing standardized questionnaire scores to the five preference self-report scales (but not to the immersion scale), two measurements of time for prophylaxis completion of two quadrants and change from baseline for the use of A/V eyeglasses and nonuse of A/V eyeglasses conditions for each of the four physiological measures. The large number of correlations increased the chance of α, or type I, statistical errors, but any correlation at the .05 probability level or better was reported to guide future research.

Intervention effectiveness. Of the 27 subjects who agreed to participate in the study, 25 completed the procedures. Two subjects, both of whom used the A/V eyeglass system in the first one-half of treatment, withdrew from the study but completed the prophylaxis. Both had a strong gag reflex and reported that the A/V eyeglasses interfered with their use of the relaxation and distraction skills they had learned to use during dental treatment.

We defined success of the A/V intervention in two ways; in both methods, the two subjects withdrew from the study were considered intervention failures. First, we used conservative criteria, in which success was defined only in those subjects who reported less anxiety or discomfort (pain) with use of the A/V eyeglasses (that is, a rating of 3 or less); any increase in either domain or neutral ratings in both anxiety and discomfort would lead to the subject being identified as an intervention failure. In this analysis, success was achieved in 20 of 27 subjects, χ^2 (1, N = 27) = 6.26, $P < .005$. Second, using a more moderate approach, success was defined as having no ratings indicating greater anxiety or discomfort (pain) (that is, no ratings greater than 4). In this approach, only the two subjects who dropped out of the study were considered intervention failures, χ^2 (1, N = 27) = 19.59, $P < .005$.

Subject and provider preference ratings. The patient form of the Posttreatment A/V Ques-

tionnaire used the neutral rating of "4" for questions 1-4 and a neutral rating of "1" for questions 5 and 6 for statistical comparison (Table 1). Subjects indicated a more positive experience ($P < .003$-$P < .001$) during treatment of the condition with the A/V eyeglasses in all of the five post-treatment preference-type questions. In the question regarding immersion in the video, subjects reported being significantly ($P < .001$) immersed in the video. There were no differences in ratings based on order of A/V presentation.

For the provider's questions, a comparison rating of "4" was used for the question regarding a subject's perceived comfort either with or without the A/V eyeglasses, and a rating of "1" was used as the standard point for statistical testing with the question about the A/V eyeglasses possibly interfering with the procedure. The clinical provider perceived subjects as being more at ease while using the A/V eyeglasses; the interference rating was significantly in the direction that indicated no problems (Table 1).

Time. Although the treatment protocol for the clinician was to attempt to equate the procedure time across the two conditions (that is, treatment with use of A/V eyeglasses and without), there still was a time difference (Figure 3). We conducted an order by condition ANOVA, and the interaction was significant ($F_{1,25} = 6.96$, $P < .01$). The condition main effect also was significant ($F_{1,22} = 6.54$, $P < .02$). The order main effect was not significant ($F_{1,22} = 2.36$, $P > .10$). Follow-up Tukey's HSD tests revealed that cleaning and examination time was longer for subjects whose first condition was without the use of the A/V eyeglasses, relative to those for the other possible conditions/orders.

While the audiovisual system can be offered to all patients without medical or psychological contraindications, it may be a particularly useful tool in the distraction of mild to moderately anxious patients.

Physiology. We first analyzed both systolic and diastolic blood pressure, as well as pulse and respiration rate, using ANOVAs; order and condition (that is, baseline, after use of the A/V eyeglasses and after no use of the A/V eyeglasses) were factors. In these analyses, only pulse rate showed any significant effects, and then only with the condition factor ($F_{2,46} = 5.55$, $P < .01$). Tukey's HSD tests indicated that pulse rate was highest at baseline (mean of sample, or M, = 71.1 beats per minute, or bpm; ± 11.9 SD) than after use of the A/V eyeglasses (M = 67.0 bpm, ± 9.3 SD) or after nonuse of the A/V eyeglasses (M = 67.2 bpm, ± 10.6 SD).

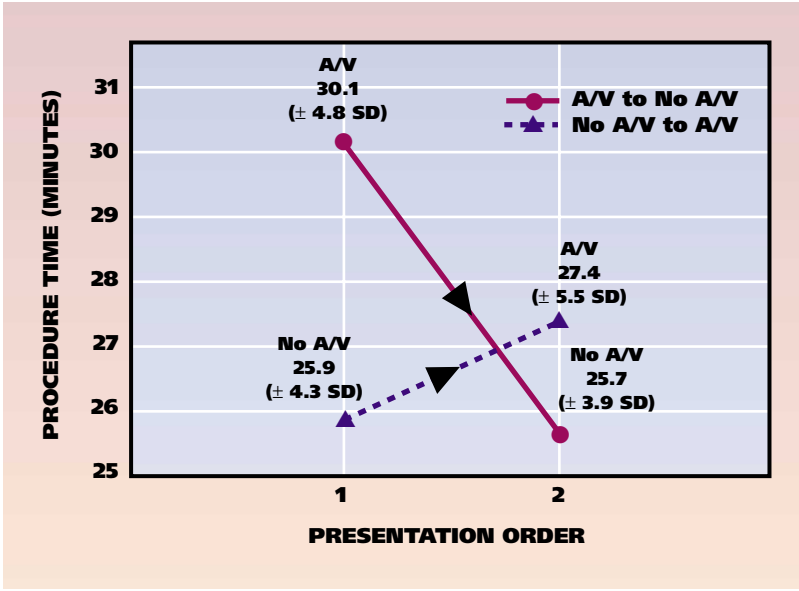

Figure 3. Means (± standard deviation) for time spent in completing prophylaxis on two quadrants by order (either use of audiovisual, or A/V, eyeglasses and then no A/V eyeglasses, or non use of A/V eyeglasses first followed by use of A/V eyeglasses). Arrows indicate direction (and thereby order) of procedures.

To further explore these data and to assess for possible effects of dental fear level, we used additional ANOVAs with the four physiological measures. We divided participants into high and low fear groups, using total DFS scores, by sex. We then conducted ANOVAs with condition and dental fear level (that is, high or low) as factors. Systolic blood pressure had a significant effect for condition ($F_{2,46} = 3.20$, $P < .05$), as again was true for pulse rate ($F_{2,46} = 5.20$, $P < .05$). Systolic blood pressure was highest immediately after the condition with no use of A/V eyeglasses (M = 118.4, ± 20.5 SD) and lowest at baseline (M = 112.6, ± 19.4 SD), while it was in the middle after the use of the A/V eyeglasses condition (M = 116.2, ± 18.0 SD). Tukey's HSD tests revealed that the only difference was between the baseline value and that after nonuse of A/V eyeglasses. No additional effects for any other physiological measures were significant.

Standardized questionnaires. Scores for the DFS and FPQ-III, including their subscales, are presented in Table 2. These scores are somewhat

TABLE 2

SUBJECTS' MEANS AND STANDARD DEVIATIONS ON STANDARDIZED QUESTIONNAIRES.

QUESTIONNAIRE	MEN'S MEAN (± SD*)	WOMEN'S MEAN (± SD*)	BOTH SEXES' MEAN (± SD*)	POSSIBLE RANGE
Dental Fear Survey				
Anticipation/Avoidance subscale	9.9 (2.6)	11.4 (4.4)	10.7 (3.7)	8-40
Fear of specific stimuli subscale	11.9 (4.8)	14.7 (5.6)	13.5 (5.4)	6-30
Physiological arousal subscale	7.8 (2.1)	9.8 (3.1)	8.9 (2.8)	5-25
Total score	31.2 (9.0)	37.5 (11.2)	34.7 (10.6)	20-100
Fear of Pain Questionnaire-III				
Severe pain subscale	27.4 (12.3)	28.3 (8.7)	27.9 (10.2)	10-50
Pain subscale	16.8 (6.4)	17.7 (4.5)	17.3 (5.3)	10-50
Medical/Dental pain subscale	21.5 (6.4)	25.0 (8.0)	23.5 (7.4)	10-50
TOTAL SCORE	**65.7 (23.0)**	**67.9 (16.9)**	**67.0 (19.4)**	**30-150**

* SD: Standard deviation.

lower than those that have been found with dental patients in other studies. For example, the total DFS score for the entire sample was less than that for a group of routine dental patients[15] who had a mean score of 42.5 (± 15.8 SD; one-sample $t_{24} = 3.67$, $P < .001$). Similarly, total FPQ-III scores for this sample were lower than this same comparison sample ($M = 78.9$, ± 29.7 SD; one-sample $t_{24} = 3.08$, $P < .005$). There were only a few significant correlations between questionnaire scores and other measures. Total DFS score was significantly related to the anxiety rating (that is, the second item of the subject part of the Posttreatment A/V Questionnaire) concerning the treatment ($r_{24} = -0.41$, $P = .04$). Interestingly, the higher the DFS score, the more likely subjects were to rate their anxiety level while using the A/V eyeglasses as "less." Also, total DFS score was positively related to time spent in prophylaxis during the use of A/V eyeglasses condition ($r_{24} = 0.40$, $P = .047$). Conversely, the FPQ-III Severe Pain score was negatively related to time required for prophylaxis in the no use of A/V eyeglasses condition ($r_{24} = -0.41$, $P = .045$).

DISCUSSION

Although this investigation still is exploratory, the highly favorable responses by the subjects who completed the study support and extend prior research,[18-20] demonstrating the utility of the A/V eyeglasses system in dental prophylaxis with most patients. All of the subjects who completed this study would prefer to use the A/V eyeglasses again during dental procedures. Several subjects previously treated by the clinician reported that they found the virtual reality system to be "unique" and "interesting." While the A/V system can be offered to all patients without medical or psychological contraindications, it may be a particularly useful tool in the distraction of mild to moderately anxious patients. The positive correlation of DFS scores and reduction of anxiety for the subjects completing this study supports prior research,[16,17] demonstrating that the use of video distraction in the dental setting can reduce anxiety. It should be noted, however, that this A/V technology is but one of many different types of distraction that can be used in the dental setting.[16,17]

Some subjects said they missed the interaction with the clinician while using the A/V eyeglasses. This relative lessening of the amount of social interaction, however, may account for the time savings demonstrated while the A/V system was used. For short procedures or treatment of new patients, use of the A/V eyeglasses actually may not result in a time savings, since verbal preparation before the procedure and discussion of findings during the treatment will need to be conducted. For long procedures or treatment of established patients accustomed to procedure routines, use of the A/V system may provide a time benefit. In an effort to control variability in use of the A/V device, the investigators choose to have all subjects view the same demonstration film. In clinical applications, however, it would be beneficial to allow patients to choose whether to use the A/V system and, if so doing, to choose among videos provided by the practitioner or view one they brought in themselves.

Correlational findings with the DFS and FPQ-

III must be considered preliminary, given the large number of comparisons. Nevertheless, these questionnaires appear to be importantly related to A/V effects on anxiety. Moreover, these instruments each appear to measure individually the factors involved in the amount of time required for prophylaxis. Certain patients with somewhat higher dental fear scores may respond particularly well to the distraction provided through the A/V eyeglasses but still may require more time for the dental procedure. Patients highly fearful of severe pain appear to require less procedure time during prophylaxis without the use of the A/V eyeglasses. Perhaps they strive to remain quiet and still during treatment, so as to reduce the possibility of pain that accidentally is inflicted on them because of their unexpected movement.

Lower DFS and FPQ-III scores were found in this study's sample compared with a sample from another study.[15] This lower level of reported fear is understandable given that these were routine dental prophylaxis patients in the dental school's faculty practice. Also, about one-half were returning patients who had been seen previously by the treating clinician. Though the anticipation of pain during dental prophylaxis makes dental hygiene–related anxiety comparable with dental anxiety for many patients,[7] use of A/V eyeglasses should be studied with patients undergoing more extensive dental treatment that possibly may involve local anesthetic or the use of a high-speed handpiece.

Ramsay and colleagues[23] stated that distraction may not be effective in diverting the attention of a patient with a severe gag reflex away from gag-eliciting or anxiety-inducing stimuli. Our present results are consistent with that conclusion in that the two subjects who did not complete this study were highly anxious and had severe gag reflexes. Both reported that the video distraction did not allow them to concentrate on their own effective, previously learned techniques to control gagging. The ability to be deeply distracted by the A/V apparatus, therefore, could adversely influence patients with strong gag reflexes. Identifying such patients, and thus excluding them in a screening process, can prevent needless distress and nonproductive time spent in the orientation phase of A/V apparatus use; the efficacy of this technique might be improved as well.

The systolic blood pressure and pulse rate effects found in this study are interesting in light of demonstrated acute negative effects of dental treatment on patients' physiological responses[24-27] and merit further investigation, particularly in more invasive and stressful dental procedures beyond that of routine prophylaxis. There is consistency between studies in pulse rate findings,[20] although there likely also is a decreasing trend of cardiovascular responsivity across the course of a dental appointment.

It was not possible for the treating clinician to be "blind" to the study protocol, as she is one of the investigators. The A/V eyeglasses posed no technical interference in scaling and polishing and, in fact, increased the clinician's comfort, which resulted from perceived enhanced patient comfort and satisfaction.

CONCLUSIONS

Taken together with prior research, results suggest that the use of an A/V distraction system may be a beneficial option for patients with mild-to-moderate fear and anxiety associated with dental hygiene treatment. The A/V distraction system used may be a useful adjunct in dental offices to help reduce anxiety, discomfort, boredom and the time required to perform routine dental procedures. For highly anxious patients who already use self-induced relaxation techniques to cope with dental treatment, however, this approach actually may interfere. Use of screening questionnaires to identify a patient's anxiety level was found to be helpful and merits further investigation in other areas of clinical dentistry. ■

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The authors thank John T. Sorrell for assistance in the preparation of this manuscript.

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