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Comparison of the effect of video glasses and nitrous oxide analgesia on the perceived intensity of pain and unpleasantness evoked by dental scaling

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Abstract

The aim of this study was to evaluate whether distraction induced by video glasses had an effect on the perceived intensity of pain and unpleasantness during dental scaling compared with the effect of nitrous oxide (N_2O) analgesia. The pain stimulus was dental scaling (removal of dental calculus) with an ultrasonic scaler. As a standardised, non-dental painful stimulus, Von Frey filaments were used. A total of 26 patients with superficial chronic periodontitis were enrolled in this randomised, controlled clinical study. The effect of video glasses was compared with N_2O in one session and the effect of video glasses versus a control situation in another. The patients rated the intensity of pain and unpleasantness evoked by dental scaling and Von Frey filament stimulation on 100-mm visual analogue scales (VAS). For dental scaling, there was no effect of video glasses on the perceived pain ($p = 0.85$) or unpleasantness ($p = 0.73$) nor of N_2O ($p = 0.69$ and $p = 0.51$, respectively) compared with the control situation. Similarly, no significant difference was found between VAS scores in the video glasses and N_2O session ($p = 0.48$, $p = 0.58$). A significant effect of video glasses and N_2O ($p < 0.008$) was found on the perceived pain intensity produced by Von Frey filament stimulation compared with the control situation, but no significant difference was seen between these methods ($p = 0.07$). Post-treatment interviews of the patients revealed that 81% of the patients in the video and 65% in the N_2O session stated that the method had some beneficial effect on their overall experience of the treatment situation. In conclusion, administration of video glasses or N_2O did not affect the perceived intensity of pain and unpleasantness evoked by dental scaling.
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Keywords: Nitrous oxide; Video glasses; Distraction; Pain; Dental scaling

1. Introduction

It is well-known that distraction can influence the perceived unpleasantness and intensity of painful stimuli. Systematic studies on modulation of pain and unpleasantness have documented an effect of showing movies and have demonstrated that humour, repulsive scenes as well as tragedy can increase pain tolerance (Weaver and Zillmann, 1994; Weisenberg et al., 1995, 1998). In a number of clinical situations, such as abdominal discomfort during flexible sigmoidoscopy (Lembo et al., 1998), burn care pain (Hoffman et al., 2000a,b), and anxiety among children undergoing genital examinations (Berenson et al., 1998), the use of video glasses has proved beneficial. In connection with dental procedures, the use of video-games and video-comedy programmes has been shown to distract patients and provide a hypoalgesic effect (Seyrek et al., 1984).

In accordance, recent experimental studies on the modulation of pain and unpleasantness induced by the cold pressor test have documented a positive effect of distraction by the use of video glasses (Bentsen et al., 1999, 2000). Regarding nitrous oxide (N_2O), it has been shown to have an hypoalgesic effect on cold pressor pain (Pirec et al., 1995) and to increase the threshold of tolerable pain and touch sensation in the face (Siiba et al., 1999). There are, however, a limited number of clinically

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controlled studies on the hypoalgesic effect of N_2O (Sprehn et al., 1994).

In a recent clinical study on dental pain (Bentsen et al., 2001), no significant effect of video glasses was found on the perceived pain and unpleasantness when the painful stimulus was the preparation of a tooth cavity for a dental filling. Since pain evoked by drilling in a tooth may be described as sharp, sudden, and intense by the patient, the present study pertained to focus on a different dental pain stimulus, dental scaling. N_2O analgesia during dental scaling is still commonly used in dental practice and has previously been shown to raise the pain threshold and tolerance when the stimulus was electric pulp stimulation (Dworkin et al., 1983).

Thus, the aim of this study was to evaluate whether distraction induced by video transmitted through video glasses has an effect on the perceived intensity of pain and unpleasantness evoked by dental scaling compared with N_2O and a control situation. The specific null hypothesis to be tested was: H_0—there is no difference between the effect of video glasses, N_2O, and a control situation on the perceived intensity of pain and unpleasantness.

2. Materials and methods

2.1. Patients

Patients with a diagnosis of superficial chronic periodontitis (pocket depths 4–5 mm), who were treated regularly with tooth scaling at the School for Dental Hygienists, Aarhus, Denmark, were offered to participate in the study. The patients were very familiar with the clinic and the treatment procedure as they all had been attending the School for Dental Hygienists for more than two years. The patients had not been previously offered N_2O-analgesia and were not familiar with video glasses. To estimate the sample size, a former experimental study by the authors on the effect of video glasses was taken into consideration (Bentsen et al., 1999). The variance was in that study 250 and when 10 in the present study was set as the minimal relevant clinical effect measured on a 100-mm visual analogue scale (VAS), it could be calculated that the minimum sample size had to be 20 ($\alpha = 0.05$ and $\beta = 0.20$). To compensate for a possible drop-out, a total of 26 patients (12 female and 14 male) with a mean age of 55 years (range 29–92 years) were enrolled in this randomised, controlled study. All patients gave their informed content in accordance with the Helsinki Declaration.

2.2. Methods

Two methods with a possible hypoalgesic effect on dental pain, video glasses, and N_2O were administered. The video equipment consisted of a video recorder (NV-HD 660 Panasonic) connected to a pair of video glasses (I-Glasses, Virtual i-O, Seattle, USA), which were used to transmit the video signal to the patient. The pair of video glasses have dimensions that enable the dentist to work almost freely in the oral cavity, and due to the minimal weight (8 ounces/240 gr.), they are comfortable for the patient to wear. The patients could choose freely between three music videos: The Beatles' "Help," a music video for relaxation (Phoenix film, Denmark), and an opera film with "The three tenors." These videos had been assessed, prior to the study by the authors to have a neutral, non-offensive content, since it was not the purpose of this study to evaluate distraction in relation to the nature of the videos. The N_2O analgesia was administered with the Analgesior and a 50% N_2O oxygen mixture was used as a standard. The N_2O was administered through a mask covering only the nose connected with a scavenging unit that removed any excess gas. Initially, only oxygen was given and gradually N_2O was added until a continuous flow of 4 L of oxygen per minute and 4 L of N_2O was reached. The patients were instructed to breathe through the nose and after approximately 4 min the scaling began. After the scaling was finished, the analgesia was terminated with breathing pure oxygen for 2 min.

In two clinical sessions with at least a one-week interval, the patients' root surfaces were scaled with an ultrasonic scaler (Hygienist, Denmark). Two of the patients' four jaw quadrants were randomly assigned to be scaled at either the first or second session. Both sessions had two randomised treatment sequences, one with video glasses and N_2O analgesia, and the other with video glasses and control (no distraction). In this way, the patients all had two treatment sequences with video glasses.

A non-dental, painful skin stimulus, Von Frey filament (Voerman et al., 1999), which is a standardised method used in similar studies (Siiba et al., 1999) with good reproducibility (Bell-Krotoskij and Tomancik, 1987), was incorporated in this study as a control to the dental stimulus. The patients were stimulated five times in a row on the upper lip with the Von Frey filament (SemmesWeinstein Monofilament, Stoelting, IL, USA) before and during the treatment. At baseline, a particular monofilament size (point load) was chosen, which was reported by the patient to produce a perceived pain of approximately 50 on a 100-mm VAS (Monofilament number: median 5.88, range 4.56–6.10). The same filament was then used during the sessions to measure the patient's general level of sensibility. The difference between the VAS score during treatment and the baseline VAS score was defined as a measure for the general effect of the distraction methods.

To evaluate the patient's general anxiety level at the two clinical sessions, Corah's dental anxiety scale (Corah et al., 1978) was completed at each session just be-

fore treatment. The hypoalgesic method was administered just after the baseline VAS rating of the Von Frey filament had been performed.

After being seated, video or N_2O was administered (except in the control situation) and after a few minutes of adaptation the scaling treatment began. Halfway through and immediately after scaling was completed in one quadrant, the patients scored their perceived pain and unpleasantness from the scaling on 100-mm VAS. The VAS were all labelled with the statements "not at all painful" and "extremely painful" and, "not at all unpleasant" and "extremely unpleasant" in either end. In addition, the patient was asked the question "Did the nitrous oxide/video glasses have any effect on your overall experience of the dental treatment situation." The patient could choose between the pre-stated answers: "positive effect," "no effect," or "negative effect." The same dental hygienist performed the treatment in all patients and both sessions. This dental hygienist was not informed about the nature of the experiment or otherwise involved in this. The data were analysed using a mixed model with random differences between persons and between days within a person, and systematic differences between the treatment sequences, the four quadrants, and the first and second sessions, as well as the fact that each subject has two video observations. The effect of the method was defined as the difference in VAS score of the pain intensity during and before treatment (before–during). The level of significance was $p < 0.05$.

3. Results

There was no difference in the scores on the Corah dental anxiety scales between the two sessions (first session: mean 7.4, SD 2.4 and second session: mean 7.2, SD 2.4). There were similarly no significant differences between sessions, neither for the baseline VAS scores of pain intensity ($p = 0.23$) nor the VAS scores during treatment with video glasses ($p = 0.39$) using the Von Frey filament as the painful stimulus.

Table 1 shows the VAS scores for pain intensity and unpleasantness induced by the dental scaling procedure. No significant hypoalgesic effect was found of video glasses on the perceived pain ($p = 0.85$) or unpleasantness ($p = 0.73$) nor of N_2O ($p = 0.69$ and $p = 0.51$, respectively) compared with the control situation. There was similarly no significant difference between VAS scores in the video glasses and N_2O situation ($p = 0.48$ for pain, $p = 0.58$ for unpleasantness). Thus, the null hypothesis could not be rejected.

The perceived pain intensity of the Von Frey filament stimulus found during the administration of both video glasses and N_2O was significantly lower compared with the control situation ($p = 0.008$ and $p = 0.001$, respectively) (Table 2). No statistically significant difference in perceived pain intensity was found between the N_2O and the video situation for the Von Frey stimulus ($p = 0.07$). Additionally, no gender difference was found in treatment effects, but males generally rated the perceived pain intensity of the baseline Von Frey filament stimulus significantly higher than females ($p = 0.003$). The difference between the baseline pain rating of the Von Frey filament and the rating during the three treatment situations (including the control) was greater with increasing age, i.e., with a non-dental pain stimulus the treatment effect in all three groups (video glasses, nitrous oxide, and control) were significantly correlated to the age of the subjects (Spearman's $\rho = 0.47$; $p = 0.016$). No other age-related effects were detected.

Table 1
The VAS scores for pain intensity and unpleasantness induced by dental scaling rated immediately after the treatment

Dental pain $N = 26$	Video				Control				N_2O			
	Mean	Min	Max	SD	Mean	Min	Max	SD	Mean	Min	Max	SD
VAS pain	16.9	0	78	18.4	15.2	0	54	15.2	13.9	0	85	21.7
VAS unpleasantness	13.2	0	81	15.7	12.7	0	52	14.4	14.1	0	85	20.0

There were no significant differences between the treatments ($p > 0.05$).

Table 2
Baseline skin stimulation with Von Frey filaments to the upper lip before treatment and the same stimulus during the treatment sequences (video, control, and nitrous oxide)

Von Frey filament $N = 26$	Video				Control				N_2O			
	Mean	Min	Max	SD	Mean	Min	Max	SD	Mean	Min	Max	SD
VAS baseline	38.1	8.4	78.8	16.4	39.8	8.4	78.8	13.8	36.4	12.0	74.6	18.7
VAS during treatment	25.2	2.8	66.4	15.8	31.3	6.2	75.8	16.6	21.3	2.8	65.2	17.6
VAS difference (effect)	12.9#	9.4	41.0	12.9	8.4	−6.6	30.6	9.5	15.2*	−0.4	43.6	12.6

$p = 0.008$.
* $p = 0.001$ (compared to control).

To the question if the N_2O and video distraction had any effect on their overall experience of the dental treatment situation, 21 of the patients stated a positive effect in the video situation, 1 stated no effect, and 4 stated a negative effect (confidence interval 6–20 for $p = 0.01$ when $N = 26$). In the N_2O situation, 17 stated a positive effect, 2 no effect, and 7 a negative effect of N_2O.

4. Discussion

In the present study, the treatment was provided in two clinical sessions one week apart. This might introduce a source of error if there were differences in the patient's level of anxiety between the two sessions. The Corah anxiety scale was therefore used to determine any such differences in levels of dental anxiety between the two sessions. The patients' dental anxiety level observed in the present study was in line with the mean anxiety score of 7.2 on the Corah dental anxiety scale recorded for 750 patients from dental school clinics, and far below the mean of 17, which has been reported for a group of dental phobics (Corah et al., 1978). The influence of dental anxiety/phobia is therefore thought to be very low in this study.

The Von Frey filaments were included in the study to obtain a standardised, non-dental pain stimulus to the skin. At baseline, an individual patient score around 50 on the 100-mm VAS for perceived pain was desired. The finding of a hypoalgesic effect of the video glasses and of N_2O to the painful skin stimuli evoked by the Von Frey filament is comparable to previous findings of an effect of video glasses on skin pain in cold pressor tests and burn wound care (Bentsen et al., 1999, 2000; Hoffman et al., 2000a,b). These findings suggest that patients' sensitivity to cutaneous stimuli may be influenced by distraction methods.

In a recent study on anxiety and behaviour during dental treatment in children (Sullivan et al., 2000), no effect of glasses imparting virtual reality scenes was found. Others have been able to distract patients to some extent with video-comedy and -games in a dental filling situation (Seyrek et al., 1984). The lack of effect of video and N_2O on the perceived pain and unpleasantness during ultrasonic scaling in the present study is, on the other hand, consistent with the findings in a recent clinical study by the authors (Bentsen et al., 2001). In this study, the pain was induced by preparation for a dental filling. The pain induced by cavity preparation was of moderate intensity (mean VAS in the control situation = 35) compared with the low intensity of pain produced by dental ultrasonic scaling (mean VAS in the control situation = 15). In experimental cold pressor pain, the pain perceived by the volunteers was considerably stronger (mean VAS in the control situation = 52). Thus, in both clinical treatment situations, there was no effect on dental pain of the video glasses, but the intensity of pain was lower than in the experimental settings. Inhalation of N_2O in combination with oxygen has for a long time been known to provide pain relief and we had therefore expected a hypoalgesic effect of N_2O. The pain perception during N_2O administration was, however, not significantly different from that seen under the influence of video glasses. Nor was there any effect of N_2O administration or video glasses compared with the control situation. Previously, some studies have shown a significant effect of N_2O on pain tolerance and on pain threshold with electrical stimulation of the dental pulp (Dworkin et al., 1983) and on tactile stimulation with Von Frey filaments and pressure pain to the skin (Siiba et al., 1999) while others have failed to show a significant difference between compressed air and N_2O on labour pain (Carstoniu et al., 1994). As mentioned by Sprehn et al. (1994), there are only a limited number of controlled, clinical studies on the pain alleviating effect of N_2O, which is quite surprising in consideration of the widespread use of the method.

We can speculate only on the physiological mechanism, that no effect of video glasses was found on pain when the painful stimulus was dental scaling whilst an effect could be demonstrated with painful skin stimuli. The general lack of a hypoalgesic effect of video glasses in dental treatment situations (Bentsen et al., 2001; Sullivan et al., 2000) together with a significant effect on cold pressor pain (Bentsen et al., 1999, 2000) and clinical skin pain (Hoffman et al., 2000a,b) could therefore suggest that dental pain is more difficult to manage than, e.g., skin pain. Both sensory-discriminative components of the pain experience in addition to affective-motivational aspects could underlie such differences. It is likely that scaling of the dental surface in the present study will have activated free nerve endings in several oral tissues including the tooth pulp, periodontal ligament, and gingiva. These free nerve endings could have nociceptive function and in particular be associated with Aδ-mechano–thermal and polymodal C-fibres (Matthews and Sessle, 2001; Sessle, 1987). The properties of some of these nociceptive fibres could be different from those in spinal nerves (Sessle, 1987). Furthermore, the tooth pulp is extremely richly innervated with free nerve endings and previous experiments have demonstrated a strong temporal and spatial summation of painful stimulation of the tooth pulp (Brown et al., 1985; Virtanen et al., 1987). Finally, there is a disproportionately large representation of the orofacial region in higher levels of the somatosensory system (Sessle, 1987). In addition to these suggestions, a number of differences in the affective-motivational responses between clinical dental pain and experimental pain (cold pressor pain in the arm and mechanical stimulation of the skin) may help explain the differential effect of the video glasses.

A general aversion against video glasses may be ruled out in this study, since none of the patients had any experience with video glasses. This was moreover supported by the fact that 81% of the patients felt that the video glasses had a positive effect on the total experience of the dental treatment situation. This finding is comparable with the findings in three former studies by the authors (Bentsen et al., 1999, 2000, 2001) in which approximately 75% of volunteers/patients wished to use video glasses again if they were to have the painful stimuli repeated. The fraction of patients, who stated a positive effect on the treatment situation when wearing video glasses, was marginally higher than when N_2O was administered. Further studies could focus more on what the patients like about the situation and why they find video glasses beneficial and, for example, incorporate measures of mood in the studies. This may show whether video glasses have a future role in clinical dentistry. The authors believe that focus will be on video glasses and other distraction media as a supplement to local anaesthesia in many clinical fields where pain and unpleasantness are involved.

The overall conclusion of this study is that no hypoalgesic effect of video glasses or N_2O was found when the painful stimulus was dental scaling. Nevertheless, a significant fraction of the patients stated that the video distraction method provided an overall positive effect on their experience of the dental treatment situation.

References

Bell-Krotoskij, Tomancik E. The repeatability of testing with Semmes–Weinstein monofil. J Hand Surg (Am) 1987;12:155–61.

Bentsen B, Svensson P, Wenzel A. The effect of a new type of video glasses on the perceived intensity of pain and unpleasantness evoked by a cold pressor test. Anesth Prog 1999;46:113–7.

Bentsen B, Svensson P, Wenzel A. The hypoalgesic effect of 3-D video glasses on cold pressor pain: reproducibility and importance of information. Anesth Prog 2000;47:67–71.

Bentsen B, Svensson P, Wenzel A. Evaluation of effect of 3D video glasses on perceived pain and unpleasantness induced by restorative dental treatment. Eur J Pain 2001;5:373–8.

Berenson AB, Wiemann CM, Rickert VI. Use of videoglasses to decrease anxiety among children undergoing genital examinations. Am J Obstet Gynecol 1998;178:1341–5.

Brown AC, Beeler WJ, Kloka AC, Fields RW. Spatial summation of pre-pain and pain in human teeth. Pain 1985;21:1–16.

Carstoniu J, Levytam S, Norman P, Daley D, Katz J, Sandler AN. Nitrous oxide in early labour. Safety and analgesic efficacy assessed by a double-blind, placebo-controlled study. Anesthesiology 1994;80:30–5.

Corah NL, Gale EN, Illig SJ. Assessment of a dental anxiety scale. J Am Dent Assoc 1978;97:816–9.

Dworkin SF, Chen AC, Schubert MM, Clark DW. Analgesic effect of nitrous oxide with controlled painful stimuli. J Am Dent Assoc 1983;107:581–5.

Hoffman HG, Doctor JN, Patterson DR, Carrougher GJ, Furness III TA. Virtual reality as an adjunctive pain control during burn wound care in adolescent patients. Pain 2000a;85:305–9.

Hoffman HG, Patterson DR, Carrougher GJ. Use of virtual reality for adjunctive treatment of adult burn pain during physical therapy: a controlled study. Clin J Pain 2000b;16:244–50.

Lembo T, Fitzgerald L, Matin K, Woo K, Mayer EA, Naliboff BD. Audio and visual stimulation reduces patient discomfort during screening flexible sigmoidoscopy. Am J Gastroenterol 1998;93:1113–6.

Matthews B, Sessle BJ. Peripheral mechanisms of orofacial pain. In: Lund JP, Lavigne GJ, Dubner R, Sessle BJ, editors. Orofacial pain: from basic science to clinical management. Quintessence Books; 2001. p. 37–46.

Pirec V, Patterson TH, Thapar P, Apfelbaum JL, Zaccny JP. Effects of subanesthetic concentrations of nitrous oxide on cold-pressor pain in humans. Pharmacol Biochem Behav 1995;51:323–9.

Seyrek SK, Corah NL, Pace LF. Comparison of three distraction techniques in reducing stress in dental patients. J Am Dent Assoc 1984;108:327–9.

Sessle BJ. The neurobiology of facial and dental pain: present knowledge, future directions. J Dent Res 1987;66:962–81.

Siiba S, Nakanishi O, Ishikawa T, Hirakawa T, Kawahara H, Imamura Y. Increase in the threshold of pain and touch sensation in the human face with clonidine plus 30% nitrous oxide. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87:294–8.

Sprehn M, Trautner S, Wiingaard S, Sørensen MB, Dahl JB. Præhospital smertebehandling med kvælstofforilte (Entonox). Ugeskr Læger 1994;156:5830–5.

Sullivan C, Schneider PE, Musselman RJ, Dummett Jr. CO, Gardiner D. The effect of virtual reality during dental treatment on child anxiety and behaviour. J Dent Child 2000;67:193–6.

Virtanen AS, Huopaniemi T, Narhi MV, Pertovaara A, Wallgren K. The effect of temporal parameters on subjective sensations evoked by electrical tooth stimulation. Pain 1987;30:361–71.

Voerman VF, Egmond Van J, Crul BJ. Normal values for sensory threshold in cervical dermatomes: a critical note on the use of Semmes–Weinstein monofilaments. Am J Phys Med Rehabil 1999;78:24–9.

Weaver J, Zillmann D. Effect of humor and tragedy on discomfort tolerance. Percept Mot Skills 1994;78:632–4.

Weisenberg M, Tepper I, Schwarzwald J. Humor as a cognitive technique for increasing pain tolerance. Pain 1995;63:207–12.

Weisenberg M, Raz T, Hener T. The influence of film-induced mood on pain perception. Pain 1998;76:365–75.