

ORIGINAL ARTICLE

Approximal caries increment in adolescents after a visual aid in combination with a comprehensive open discussion

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Abstract

Objective. To achieve greater motivation for behavioural changes; educating, motivating and supporting the patient's ability to change lifestyle factors related to the caries disease are important tasks in the prevention of the disease. The aim of this study was to evaluate whether a visual aid (Visual Caries Dialogue, VCD) in combination with a comprehensive open discussion has a beneficial effect on approximal caries development among a population of young adolescents. **Materials and methods.** The study subjects were randomized to either an intervention group ($n = 118$), where VCD was conducted, or a control group ($n = 112$) receiving traditional oral healthcare information, at the annual dental health examination. The number of caries lesions reaching through the entire enamel (D2) and dentin caries reaching through the enamel into the dentin (D3) were recorded from bitewing radiographs each year, from 2001–2004. Differences between the study groups regarding at least two new approximal surfaces with caries (D2–D3) were tested using logistic regression. **Results.** The caries increment was lower in the intervention group compared to the control group. During the 3-year follow-up, 18 (15.3%) patients in the intervention group and 40 (35.7%) patients in the control group demonstrated a DS-approximal increment of at least two surfaces with a risk ratio of 2.34 (95% CI = 1.43–3.83). **Conclusion.** Visual Caries Dialogue in combination with a comprehensive open discussion reduced approximal caries increment among young individuals. The method provides an innovative simple and low-cost way of delivering information to patients and guides busy dental healthcare personnel in the approach.

Key Words: *visual aid, visual caries dialogue, caries increment, caries prevention, clinical trial*

Introduction

Despite the dramatic decline in dental caries over the past few decades, particularly in industrialized countries and among children and young adults, the disease persists, albeit with highly skewed distribution [1–3]. Although the widespread use of fluoride toothpaste has resulted in dramatic caries decline [4–6], the disease is still a major health problem worldwide. When all stages of the continuum of the disease are taken into account; from the initial lesion to the clinically obvious, very few individuals are truly unaffected. In most industrialized countries, 60–90% of school-age children are affected and the prevalence of dental caries among adults is even higher as the disease affects nearly 100% of the population in the majority of countries [7].

Strong polarization of the caries disease in child and youth populations has been confirmed in several studies [3,8]. The groups with high caries risk and patients with high caries activity made use of the oral health services mainly for restorative treatment [9,10]. Applying early strategies to control, arrest or reverse the disease process can reduce the economic burden, pain and suffering of the patient caused by placing and replacing restorations. The long-term outcome of dental treatment, in terms of tooth survival, shows that minimal intervention in dental care is to be preferred or, to put it bluntly: no dentistry is the best dentistry [11].

Appropriate dental care and primary prevention should therefore include patient information regarding behavioural and lifestyle-related factors and the importance of sound dietary and oral hygiene habits.

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The risk for caries disease will be reduced if this is introduced at an early age. Caries is related to one's lifestyle and behavioural factors within a person's control are clearly implicated [12]. Restorative dentistry without a preventive approach does not cure the patient from the caries disease. However, in spite of our profound theoretical knowledge of caries aetiology and how to prevent and control the caries disease, dental professionals are not always successful in encouraging high-risk adolescents to prevent or arrest an on-going caries process. It is extremely important to engage this group of patients in order to reduce the risk of developing injuries/lesions by one of the most prevalent—but also preventable—chronic human diseases worldwide.

It has been demonstrated that the motivational interview (MI) approach is a useful intervention strategy in increasing the patient's awareness of the potential problems caused, consequences experienced and risks faced as a result of the behaviour in question [8,13,14]. Other means of providing information include visual aids such as pamphlets, drawn pictures, etc. [15]. The combination of a dialogue influenced by the MI-results and a visual aid could reinforce the prevention message. Innovative, simple and low-cost caries prevention methods would be coveted by dental professionals, if there was evidence of efficiency.

The aim of the present study was to evaluate if a visual aid, here called Visual Caries Dialogue (VCD), in combination with a MI-influenced dialogue, can decrease the caries development among a population of young adolescents, 11–14 years. The intervention group received VCD in combination with a comprehensive open discussion and the control group traditional oral healthcare information at the annual dental check-up visit. Thus, our research hypothesis was that the group receiving VCD would show significantly lower caries increment than those in the control group, at follow-up.

Materials and methods

Subjects

The study group comprised adolescents born between 1987–1990 who were regular patients at the public dental clinic in Tibro, Sweden. Socio-economically, the catchment area represents an industrial municipality with 10 600 inhabitants and the naturally occurring fluoride in the drinking water was 0.2 mg/l. The inclusion criteria were young adolescents, 11–14 years of age and with one dental health examination planned for the year 2001. The exclusion criteria were: being under orthodontic treatment with fixed appliance or with a parent working at the public dental clinic in Tibro. Children with siblings already included in the study were also excluded.

Trial design

The study was approved by the Ethics Committee at the University of Gothenburg (Ö 248-00). The randomization was stratified by the year of birth and from the clinics' recall lists, using computer-generated random numbers. Information regarding the study and an invitation to participate in the study together with informed consent was sent by mail to the patients and their guardians. The patients were then called for a regular, annual dental examination. If the patient accepted to participate in the study, informed proxy consent was obtained from their parents or guardians. The study design and numbers of subjects at each phase of the study are described in Figure 1. The study period extended from the baseline dental health examination in 2001 to the dental health examination in 2004, with annual dental check-ups. All dental examinations were performed by the dental team to which the child was allocated. The number of dentists involved in the study varied during the study period; in 2001 four dentists were involved in the study, in 2002 five, in 2003 six and in 2004 five dentists.

Interventions

At the regular dental health examination during the years 2001–2004, the intervention group received VCD in combination with a comprehensive open discussion. Dentists responsible for the study were trained prior to the study start by attending meetings concerning how to perform motivational interviewing. Follow-up meetings at the clinic then occurred subsequently, during the study. In the present study, the VCD included individual discussions to achieve behavioural changes. The patient's motivation to change was emphasized in order to support, strengthen and encourage the patient. The VCD was carried out in an informative constructive manner, with the purpose of helping the patient to appreciate the value of change. Emphasis was put on interactive conversation, where the dentist together with the patient, for example, discussed why caries lesions develop. The interactive conversation also aimed to mobilize the patients' own ability to make behavioural changes and there together with the patient the dentist discussed what the patient herself or himself could do about the situation. For example, sugar intake, frequent snacking, tooth brushing habits and the use of fluoride was discussed. Emphasis was also put on creating a mutual understanding in which the patient was encouraged to take his/her own responsibility with support from the dentist and also to raise the awareness of the benefits of preventing new caries lesion. The conversation was supported by a VCD. The VCD is a standardized visual form used to mediate and structure the dialogue between the

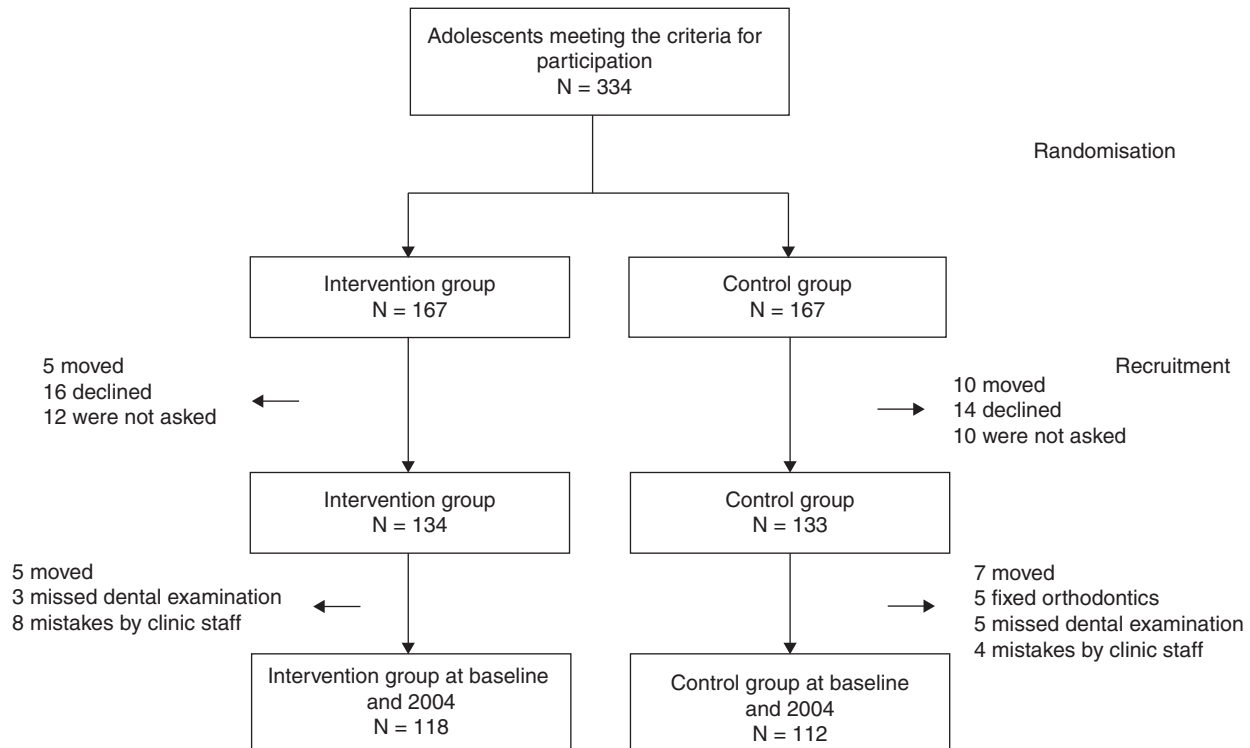


Figure 1. Flow chart of the study. Mistakes by clinical staff were, for example, that the staff provided the VCD-supported information to the control group.

dentist and the patient regarding the patient's dental health, dental self-care and risk factors for caries (Figure 2). The dentists responsible for the VCD and the comprehensive open discussion were instructed by one of the authors (AH) prior to study start and during the study by attending meetings concerning how to achieve an interactive discussion with the patient in a positive way. The instruction included information on how to fill out the VCD in the counselling setting and together with the patient. The dentists were instructed how registration of diagnosed enamel and dentin caries should be marked on the image of a dentition. They were also instructed to circle the appropriate area in the red-yellow-green behaviour scale, i.e. the point on the scale that best matched the patient's own history regarding oral healthcare habits (frequency of tooth brushing, the use of approximal aids), dietary habits, frequency of sugar intake, fluoride exposure, and medication affecting the salivary flow. The markings were made along the full range of the scale, and information was provided concerning the benefits of lying within the green area. That which was positive was commended and information about what could be improved was given in a constructive manner, e.g. 'if you want you can change this and then it will get even better' and never in an admonishing manner, just informative and encouraging. Positive changes were praised and further improvements were suggested in a constructive and informative manner.

The patients were also asked to take the VCD form home and show it to their parents. The control group received traditional oral healthcare information; counselling on dietary habits and oral hygiene instructions using the Bass technique, carried out without any pre-determined guidelines. At the annual visit, two-to-four bilateral bitewing x-rays were radiographed using Gendex x-ray equipment and bitewing projection with Kodak InSight F-speed double dental film. Film holders and a beam-aiming device were used, to achieve comparable geometry. The processed images were mounted in frames.

Outcome, radiographic examination

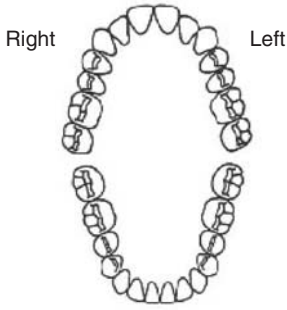
The outcome of interest in this study was measures of caries development, here called DS-a (Decayed Surfaces-approximal). Bitewing radiographs were available in all subjects at baseline, i.e. 2001, and at follow-up, i.e. 2004. At appointments between baseline and follow-up radiographs were only taken on indication. The examination consisted of dental screening and—on individual indications—two-to-four bitewing radiographs. Approximal tooth surfaces from the permanent first premolar to the second molar were included in the follow-up. The bitewing radiographs were inspected on a light box with a magnifying ($\times 2$) loupe by an experienced dentist (AH) who was blinded to the patient's name and study group allocation. The number of caries lesions

Your dental health

Name _____

Date _____

Black = cavity that requires a filling
 Green = initial caries which can be self-repaired naturally



How often do you brush your teeth with fluoride toothpaste?

Never	Occasionally	Once/day	Twice/day
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Do you use dental floss or toothpick?

Never	Irregular	Everyday
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How often do you eat or drink per day?
(water not included)

>9	8	7	6	5
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How often do you eat sweets snack foods?

Always	Everyday	Once a week	Never
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How often do you drink soft drinks or other sugar-containing beverages?

Between meals	Only with meals	Once a week	Never
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Do you use fluoride tablets, fluoride chewing gum or rinse with fluoride solution every day?

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Do you use medicine that can cause oral dryness?

Daily	Periodically
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Do you use sugar-free chewing gum?

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Figure 2. The Visual Caries Dialogue (VCD) was used in the intervention group as a visual aid to mediate the instructional dialogue between the subjects and the dentists. In the image of a dentition, in the upper left corner, diagnosed enamel (coloured green) and dentin caries (coloured black) were registered and on the behaviour scale (red-yellow-green when coloured, where red was considered the most negative behavioural and green the most positive) the area that best matched the patient's own history regarding oral healthcare habits was circled.

on approximal surfaces, with radiolucency strictly to the enamel, reaching the amelo-dentin junction but without obvious spread in the dentin (D2) and dentin caries with radiolucency extended and with obvious spread in the dentin (D3) was recorded each year.

An incidence in DS-a of at least two new surfaces during the period 2001–2004 was the outcome measure. Intra- and inter-observer reliability was calculated; 23 sets of bitewings were inspected by AH. After an interval of 2 weeks, the procedure was repeated blindly by the same observer under identical conditions. To calculate the inter-observer reliability,

two observers (AH and LK) inspected 10 sets of bitewings independently.

Statistics

All randomized participants with baseline values at 2001 and follow-up at 2004 were included in the analysis. The Chi²-test was used to test differences between the study groups regarding the proportion of subjects who dropped out after recruitment and before 2004. A DS-a development of at least two surfaces on bitewing radiographs during the follow-up was dichotomized. Risk ratios were calculated with 95% confidence

intervals in both study groups and differences between the groups were also analysed using binary logistic regression presented with odds ratios. Since earlier caries experience is a well known risk factor for developing future caries [16], additional analyses adjusting for caries experience at baseline and what dentist they were allocated to during 2001 were performed on the outcomes. We performed a stratified analysis based on which dentist was responsible for the study subjects during 2001. Observer reliability was analysed using weighted Kappa statistics. Numbers Needed to Treat (NNT), i.e. the number of subjects needed to prevent one new outcome (DS-a increase ≥ 2) with the tested intervention (VCD) was calculated, $1/(p_{\text{control}} - p_{\text{intervention}})$. *PASW Statistics 18* and *STATA/IC 10.0* was used for statistical analyses and descriptive statistics. *p*-values less than 0.05 were considered as statistically significant.

Results

In 2001, 334 patients met the criteria for participation in the trial and were randomized. Out of those invited, 77 choose not to participate in the study. Thirty-seven patients dropped out before the follow-up in 2004. These drop-outs resulted in an intervention group of 118 patients and a control group of 112 patients. There were no significant differences between the study groups regarding differences in proportions that dropped out between 2001–2004 ($p=0.36$). Table I presents baseline characteristics in both study groups. There were no significant differences in baseline characteristics.

Caries increment—DS-a

In the intervention group, 76 subjects (65.0%) had no new carious surfaces, 23 (19.7%) had one, 9 (7.7%) had two and 9 (7.7%) had three new surfaces or more. The corresponding numbers in the control

group were 58 (51.8%) with zero, 14 (12.5%) with one, 19 (17.0%) with two and 21 (18.8%) with three new surfaces or more. During the 3-year follow-up, 18 (15.3%) patients in the intervention group and 40 (35.7%) patients in the control group had a DS-a increase of two or more surfaces. There was a lower risk in the intervention group with a risk ratio of 2.34 (95% CI = 1.43–3.83) (odds ratio 3.09; $p < 0.001$). When adjusting the analysis for previous approximal caries experience and to which dentist the subjects were allocated, the odds ratio was 3.26 ($p < 0.001$). The number of subjects needed to prevent one new case with a DS-a increment of at least two new caries lesions during the 3-year follow-up was 4.89 subjects.

During the study period eight different dentists were employed at the clinic. All but four study subjects met more than one dentist during the study period. In 2001 (at baseline), four dentists were employed at the clinic. One of them left their employment in 2001 and only examined and treated one study subject. We performed stratified analysis based on which dentist was responsible for the study subjects during 2001, excluding the dentist that only met one subject. Of the three dentists included in the stratified analysis, dentist one met 64 subjects, dentist two met 100 subjects and dentist three met 65 subjects. The intervention had a positive effect in all three strata, dentist one RR = 1.41 (95% CI = 0.67–2.97) dentist two RR = 2.62 (95% CI = 1.17–5.86) and dentist three RR = 3.95 (95% CI = 1.24–12.57).

The kappa value for intra-observer reliability was 0.98 and for inter-observer reliability 0.79.

Discussion

This study compared caries increment between a group of adolescents receiving oral healthcare information using VCD and a group of adolescents receiving traditional oral healthcare information, at the

Table I. Baseline characteristics in both study groups.

		Group			
		Intervention		Control	
		Count	%	Count	%
Sex	Boys	63	53.4%	59	52.7%
	Girls	55	46.6%	53	47.3%
Birth year	1987	22	18.6%	21	18.8%
	1988	26	22.0%	24	21.4%
	1989	37	31.4%	36	32.1%
	1990	33	28.0%	31	27.7%
DMFS-a at baseline	0	104	88.1%	99	88.4%
	1–2	12	10.2%	10	8.9%
	≥ 3	2	1.7%	3	2.7%

annual dental visit. The caries development was lower in the intervention group compared to the control group regarding approximal caries reaching through the entire enamel, as detected on bitewing radiographs during a 3-year follow-up. The research hypothesis was therefore verified.

It is important to distinguish the VCD from regular preventive information. The VCD in combination with the MI-inspired dialogue used in this study is a specific type of conversation method and may include brief, individual discussions to achieve behavioural change. In the present study, great effort was made to strengthen the patient's ability to achieve change and to help the patient appreciate the value of change. Together, the dental personnel and the patient filled out the VCD form and discussed behavioural changes, all in a constructive and encouraging manner. Studies have shown that patient education, individually or in groups, can have a great impact on caries development in children and adolescents. The importance of an early start to dental health education, outreach activities and motivational interviewing is emphasized in the review article by Twetman [17]. This was also confirmed in the study by Kowash et al. [18] in which mothers, from the time their child was 1 year old, were regularly visited in their homes over a period of 3 years. Trained health educators informed the study groups about diet, oral hygiene, tooth brushing instruction and the importance of using fluoride toothpaste. The control group was never visited and received no dental health education and the children were only examined at 3 years of age. The preventive programme was effective and differences in caries increment between the groups of children visited regularly and the control group were statistically significant ($p < 0.001$). In the present study, in which the participants were older (11–14 years), the dental health education was addressed directly to the subjects. It can be assumed that the parents were not comparably involved as in the Kowash study, even though the adolescents were encouraged to take their VCD home to show their parents or guardians. It can also be speculated as to whether an adolescent's level of motivation for behaviour changes can be compared to that of a new mother. Nevertheless, the VCD investigated in the present study was seen to be successful. Additionally, we also noted that during the interactive conversation dentist–adolescent underlying risk behaviour of the patient could be detected, which possibly would have been missed at a more traditional dental check-up appointment.

Behavioural changes rely upon identifying and mobilizing the patients' own active involvement and motivating these behavioural changes. The most enduring motivating factor is greater responsibility. Axelsson et al. [19] reported in their study in which a group of 12–15-year-old children were trained to take

responsibility for their own oral health, that this was a useful intervention strategy to avoid new approximal dentin caries lesions among adolescents. The intervention group was trained to establish needs-related oral hygiene habits based on self-diagnosis and a new behavioural principle for the establishment of habits. The control group received no information or instruction. Significantly fewer ($p < 0.001$) new approximal dentin caries lesions were diagnosed in the study group compared to the control group. In the present study, the intervention group received oral healthcare information using a VCD-form and the caries increment after 3 years was significantly lower than in the control group. It is not possible to separate the effect of the visual aid from the motivational approach. To our knowledge, there are no published papers evaluating visual aids in dental-health education. In the present study we demonstrated a method which is simple to apply and which also provides an innovative, simple and low-cost way of delivering information to patients as well as guiding busy dental healthcare personnel in the approach. To clarify the effectiveness of this intervention strategy we also calculated NNT. The ideal NNT in this population based on the control group is 2.80, where everyone improves with treatment. The higher the NNT, the less effective is the treatment. We calculated an NNT value of 4.89. These results seem likely to have the same effect in other populations where the caries prevalence is similar to that of Tibro. In 2002 the mean DFS-a in 19 year olds was 1.19 in Tibro and 1.35 in Sweden [20].

Randomization is important when designing a study since it provides the opportunity to control for unknown confounders. A shortcoming in the present study is that the randomization was performed before the recruitment of subjects. This is a potential weakness since several subjects declined or missed participation after being randomized. However, since the number of drop-outs before recruitment was very similar in both study groups it seems unlikely that it had any major impact on the results. Those included in the statistical analyses were only those recruited in 2001 and still participating at the dental health examination in 2004. The subjects were treated and examined by the dentist to whom they were allocated and we were not able to adjust the results on the basis of the dentist.

The limitations of radiographs for detecting approximal caries are widely known [21,22]. Due to low attenuation of radiation in the demineralized zone, the typical radiographic appearance of caries shows a radiolucent area; however, 40–60% of tooth decalcification is required to produce the radiographic image [23]. By the time an approximal lesion is radiolucent, it has often progressed well into the enamel. All radiographs in the present study were analysed on the same light box. The high intra- and

inter-observer reliability found confirms that interpretation of the bitewing images was performed with high diagnostic accuracy. However, a larger number of observers would have been preferable to minimize random errors. Results from a study by Mejäre et al. [24] showed that the most skilled interpreter analysing radiographic images of the best quality will not always be able to distinguish between perfectly sound and diseased surfaces. In order to eliminate this known diagnostic error in the present study and if difficulties in distinguishing between a sound surface and a surface with initial caries arose, the analysed surface was then considered to be intact.

The Visual Caries Dialogue was demonstrated to be a useful intervention strategy. The caries increment was lower in the intervention group compared to the control group regarding approximal caries reaching through the entire enamel detected on radiographs during a 3-year follow-up. The method can be greatly beneficial and can improve dental health. The method provides an innovative, simple and low-cost way of delivering information to patients and guides busy dental healthcare personnel in the approach.

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