

The views of examiners on the use of intra-oral photographs to detect dental caries in epidemiological studies

U. Boye¹, G.R.K. Foster², I.A. Pretty³ and M. Tickle¹

¹The Oral Health Unit, School of Dentistry, University of Manchester, UK; ²Independent researcher, Malvern, Worcestershire, UK; ³The Dental Health Unit, Manchester, UK

Aim: The aim of the study was to obtain the views of examiners on their experience of using intra-oral photographs as a means of detecting caries in epidemiological studies compared to an established visual examination method. **Method:** A focus group discussion was conducted with five examiners experienced in an established visual examination method after they had performed visual dental examinations of a sample of children as well as assessed intra-oral photographs of the same children. **Results:** The time taken by examiners to assess intra-oral photographs becomes extended when compared to performing a visual examination. The ability to assess intra-oral photographs on a screen at a convenient time and place was considered advantageous. The examiners found it easier to make caries detection decisions on intra-oral photographs of primary teeth than permanent teeth. Adequate removal of debris and moisture control prior to obtaining the photographs were considered important. **Conclusion:** The views of examiners in this study suggest that to improve the utility of photographic method, further research is needed to determine adequate drying methods for use in the field. Consideration should be given to a time-limited, standardised presentation of the photographs including the size and resolution. Specific training on caries detection from photographs is also required.

Key words: *intraoral photography, dental caries activity tests, epidemiology, oral examination, qualitative evaluation, examiners' views*

Introduction

Despite a decline in the prevalence of dental caries in many countries, it still remains the most significant disease in children (Marthaler, 2004). The prevention and treatment of dental caries consumes most of the dental resource allocation of state-funded health budgets. Data collated through dental epidemiological studies to inform the allocation of these resources should provide dental public health planners with appropriate information to complete this task efficiently. Different caries detection methods of varying sensitivity and specificity dependent on the degree of progression of lesions have been described in the literature (Bader *et al.*, 2001). The choice of caries detection method for such studies is dependent on a numbers of factors. Validated caries detection methods with high sensitivity for identifying early carious lesions are useful in longitudinal caries progression studies and in the clinical management of the disease (Ismail, 1997). Epidemiological assessment of caries traditionally relies on visual assessments. Many countries including the UK use traditional visual examination methods for their national epidemiological studies and record caries at the dentinal level. The visual examination method used in the UK National Health Service (NHS) epidemiological surveys was developed by the British Association for the Study of Community Dentistry (BASCD) (Pine *et al.*, 1997). This method is however unsuitable for comparative studies where examiner "blinding" to some attributes of participants is required to reduce the risk

of bias. An alternative inexpensive and simple method of "blinding" suggested by Boye and colleagues (2012b) is for examiners to assess intra-oral photographs of participants' teeth instead of direct visual examination. An additional benefit of this method is the ability to archive the obtained photographs, undertake repeated and remote analysis and the possibility of using a differently skilled workforce such as hygienists to acquire the images which may reduce the costs of such surveys.

This method has been shown to be a valid and reliable means of assessing caries (Boye *et al.*, 2012b). It has also been shown to be acceptable to children who are the main participants of the caries epidemiological surveys (Boye *et al.*, 2012a). The experiences and views of examiners on diagnosing caries from the intra-oral photographs in epidemiological surveys have however not been reported in the literature. This is an important aspect of the implementation of such systems. While they may be scientifically and philosophically ideal, unexplored barriers to their effective and efficient use in the field could hinder their uptake. By understanding the views of the users such barriers can be explored, and often reduced or eliminated.

The aim of this study was to obtain the views of examiners on their experience of using the established visual examination developed by BASCD and the assessment of intra-oral photographs as means of detecting caries in epidemiological studies and explore how these experiences were influenced by some of the practical issues encountered during the examinations.

Method

Ethical approval was obtained for this study from the National Research Ethics Service (Reference Number: North West 10 09/H1011/57).

The examiners used in the study had been trained and calibrated to the BASCD caries examination protocol as members of the UK National Epidemiological Surveys team (outside the current study). Completion of this national training and calibration in the BASCD caries examination protocol was used as the main selection criterion for recruitment of the examiners into this study. Five examiners, all dentists trained, calibrated and experienced in the use of the visual examination method developed by BASCD for use in the UK NHS dental epidemiology programme, took part in the study. These examiners had each participated in the visual examination of more than 200 5-year-olds and 200 10/11-year-olds in schools. The same dentists (after appropriate training) had also assessed intra-oral photographs of the same 400 children as a means of detecting caries. The intra-oral photographs were obtained by another examiner (not one of the 5) at the time when the visual examinations were carried out. For the photographic assessments, each of the five examiners was provided with a Universal Serial Bus (USB) flash drive loaded with labelled folders containing a set of intra-oral photographs of each participant's teeth at least two months after the visual examinations. Each examiner viewed the photographs on either laptop or desktop computer screens at a time of day and room conditions of their choice. Caries was diagnosed at the "caries into dentine" level. Examiners recorded their diagnosis on score sheets.

The examiners convened three weeks after they had carried out both the visual examination and photographic assessments for a focus group discussion to explore their views on their experiences of using the two methods and also to clarify any issues that needed further explanation.

All five examiners were invited to attend the focus group and they were given the topic areas that would be covered in the discussion. A member of the research team facilitated the discussion. Another individual was present solely to take additional notes about the group interactions. Before the start of the focus group discussion the facilitator informed the participants of the ground rules and established the guiding principles of the discussion. Confidentiality was also assured.

The areas discussed by the group included the participants' views on the following topics:

- The conditions for conducting the examinations
- Their experience of the two examination methods
- The differences between the use of intra-oral photographs and visual examination as means of detecting of caries
- Their perceived advantages of assessing intra-oral photographs to detect caries instead of performing a visual examination using BASCD criteria
- Their perceived advantages of performing a visual examination using BASCD criteria instead of assessing intra-oral photographs to detect caries
- How the intra-oral photographic method could be used for future epidemiology work
- Their views on how the intra-oral photograph method could be improved.

The focus group discussion was audio recorded digitally and lasted for 50 minutes.

An audio typist transcribed the focus group discussion recording verbatim. Thematic analysis identified the common themes from the transcripts by first assigning codes to the emergent themes then, using an inductive process for constructing interpretations, the codes were used to develop an overall classification of themes. Transcripts were then closely examined for sections that did not fit the emergent framework. The overall classification of themes was assured by an independent researcher's analysis of the transcripts and the notes taken during the focus group discussion (Barbour, 2001). To add to the credibility and trustworthiness of the research process, a protocol for the method and data analysis used in the study was produced to create an audit trail for reproducibility (Jootun *et al.*, 2009). In the presentation of the study findings, selected quotes from the focus group discussions are used to illustrate how analysis of the data reflects the views of the examiners (Gill *et al.*, 2008).

Results

All the five examiners contributed to the focus group discussion. As they were experienced in the use of the visual examination method, in their discussions, the characteristics of the intra-oral photographic assessments method were compared to the former. The main themes that emerged from discussions were: viewing/examination conditions; the viewing/assessment process; utility; and, improvements.

Viewing/Examination conditions

This theme relates to the participants' responses about the environments in which the photographs were assessed including lighting, time of day and type of viewing screen used (examples have the examiner's identification number appended):

"when I was doing it in work it was just natural light through the window, but at home our computer is on the landing, we don't have a window there, so that was artificial light" ^{#2}

"I did mine day and night, on a desk top and it was either with natural light or with just a normal light bulb." ^{#1}

"... I used one (desktop) in work and one (laptop) at home so I was using different computers and I didn't find any difference there" ^{#5}

and "I did try doing them on my laptop but I felt that... the screen was too small, so I ended up doing it on one with a full size you know" ^{#2}

Viewing/Assessment process

This theme comprised the participants' views on their experiences of assessing the intra-oral photographs and the associated demands on the examiners as compared to the visual examination method. The following sub-categories were identified: duration of viewing which consists of time taken to view an intra-oral photograph, time taken to view all the intra-oral photographs of a patient and the total length of time participants spent "sitting" carrying out all the assessments. Some spent

whole days on this activity or described it as taking “an awfully long time”^{#1} but acknowledged that it “got easier towards the end”^{#2}.

“I think I took longer over the photographs because if I was in doubt at all, I was staring at the photographs for a long, long time, whereas if you have got a wriggly child you do just, go in, have a quick look you have got your epidemiology head on so you know it’s a quick look, score low and that is what we are used to doing, but when there is a photo on the screen and you think, there might be a shadow there, you can spend a long, long time and you look at it from different angles, you know, so I think the photographs probably took me longer.”^{#5}

Regarding the mental and physical demands of the viewing process;

“I tried to just do one school per evening, so that’s 30/40 children, well I never really managed 40 and so it was basically an hour and then, I had lost concentration really.”^{#2}

“I think I tried to limit it actually because I started getting very sharp pains down my side of the neck, so I limited it to about an hour, and then went off and did something else for 10 minutes and then came back at it fresh”.^{#1}

Then any additional support required such as a scribe.

“I actually used (dental nurse) as a scribe, so I have them (paperwork) and she did as we do in when we are out in the field and that was actually very good. We got through it very quickly then.”^{#3}

Utility

This category relates to the participants’ views on the utility of the two examination methods. They described advantages and problems of each method. They found it difficult to make decisions about the presence of tooth-coloured restorations and the extent of carious lesions especially when assessing the intra-oral photographs of the permanent dentition.

“Because of my greatest uncertainty when assessing early lesions and tooth coloured fillings I found it easier to assess the 5-year-olds’ photographs than the older children’s”^{#5}.

The use of a zoom facility to enlarge the view of the photograph was suggested by one participant as a way to aid caries detection decisions when there is doubt.

“it would be great if you could zoom in, and have a look at the images”^{#4}

The rest of the participants however voiced concerns about altered perceptions of the magnified tooth and questioned whether that would be helpful as in their opinions photographs needed to be viewed in a standard way in studies involving multiple examiners.

“I didn’t think that is the right thing to be doing in that situation. Because you are not having a standard examination, you know you are looking at one patient, with it at one magnification and another patient with something completely different so your results are going to be quite dramatically different...”^{#1}

The examiners said that the tactile sense derived from touching the teeth with a probe was a valuable aid in detecting caries, restorations, fissure sealants and malformations of enamel or dentine; hypoplastic teeth could be mistaken for caries on a photograph.

“I suppose that you can look, you can move the child, you can move your light, you can move your mirror and it’s what we are used to, that’s more what we are trained in, the photographs are still very new to us, aren’t they?”^{#3}

“Not being able to touch it (the tooth) with a probe; that was difficult. I think the ones that were obviously healthy or obviously carious that was quite easy and quite quick but it was the doubtful ones, that was where I was having difficulty and spending a lot of time, and still not resolving it at the end you just wanted to poke them really, didn’t you?”^{#5}

The examiners reported that saliva and debris on teeth were problematic when assessing the photographs.

“I think they were very good photographs but saliva is still a problem. Saliva definitely yes, It only needs a tiny amount of saliva and the light shines off it doesn’t it, and you can’t tell if there is a cavity.”^{#3}

Despite the drawback of extended viewing experienced by some examiners, being able to look at an intra-oral photograph of a tooth on a screen at any time “examining the subjects from the comfort of your arm chair!” without “fighting a tongue, cheek and a wriggly child”^{#4}, was considered advantageous.

This theme also includes the participants’ expressions of further applications for the photographic method in dental epidemiology studies. These were the use of intra-oral photographs for remote training and calibration of examiners in epidemiological skills and in longitudinal caries progression studies.

Improvements

This theme sums up the participants’ views on how the intra-oral photographs examination method could be improved to enhance its usefulness. The main improvement they suggested for the photographic method was the use of more efficient means of moisture and debris removal such as compressed air instead of cotton wool prior to taking the intra-oral photographs.

“... yes, dry with air, if you were just doing photographs then you might be able to get a better views ... definitely yes, dry with air ...”^{#2}

Also more training on assessing intra-oral photographs for caries was requested by the group

“we are trained to look at the teeth and score them in a clinical situation, but I think, to have a training exercise looking at the photograph and as we do to be able to discuss with other people because it is slightly different and to get your head round this scoring ... on photographs I think you do need a bit more training about that”.^{#2}

Discussion

The study explored the views of a number of experienced examiners trained and calibrated in the visual examination method developed by BASCD for use in the UK NHS dental epidemiology program on their experiences of assessing intra-oral photographs as a means of detecting caries as compared to the BASCD developed visual method. The main findings of the study are that the time taken by examiners to assess intra-oral photographs

becomes longer when compared to performing a visual examination. The ability to assess intra-oral photographs on a screen at a convenient time and place was considered advantageous. The examiners found it easier to make caries detection decisions on intra-oral photographs of primary teeth than permanent teeth.

In common with other qualitative research, a limitation of this study is that in its pursuance of an in-depth understanding of the subject under investigation, a small number of participants who may not be representative of all examiners were engaged in the study. This makes it less easy to generalise the findings from the study to the population (Allen *et al.*, 2010). However the purpose of this method of enquiry is to uncover all the issues pertinent to the subject matter not their prevalence or frequency distribution (Green and Thorogood, 2009).

As experienced examiners in the visual examination method, the participants acknowledged and expressed the need for and requested further training in the assessment of intra-oral photographs as a means of detecting caries. This is similar to the finding by Assaf *et al.* (2006) that although the use of new methodology may be possible in epidemiological surveys, strategies to improve training in diagnosis and calibration of examiners are necessary. The use of photographs enables such calibrations to be undertaken with ease. A standard portfolio of photographs can be prepared and presented to examiners for such purposes. It is also possible for this calibration to be undertaken online, with real time responses to decisions and immediate feedback. Such calibration can be undertaken at the examiners' convenience and does not require access to schools or children. The use of a standardised and validated calibration set of photographs that can be used across multiple examiners, in multiple sites over multiple years is advantageous.

The examiners' familiarity with the visual examination method could explain why most of them reported spending less time making a diagnosis during the visual examination method while the photographic method took time to get used to. This is because in the examiners' experiences the whole mouth is in sight and can be viewed as part of the person during the visual examination. Also the child being examined as well as any equipment and the instruments e.g. light source and hand mirror can be repositioned to aid the examiner. None of these options were available to the examiners in the photographic method. The ability of those collecting data to be able to view the teeth and mouth as an extension of the person and their environment as part of the diagnosis decision making process however could be a potential source of bias in epidemiology studies evaluating oral health interventions (Milsom and Mitropoulos, 1990).

The participants reported that sitting for an extended time in front of a computer screen, interpreting photographs, made physical and mental demands on them. The participants expressed that they experienced tiredness, physical strains and loss of concentration. Physical symptoms included sharp pains down the side of the neck, dry eyes, eye strain and wrist strain. As in studies of those working with visual display units (Korhonen *et al.*, 2003) has shown, these factors made it more difficult to make a diagnosis. The examiners however had ways of overcoming these difficulties that included working

for shorter periods, taking breaks away from the computer and "*coming at it fresh*". A way around this is to standardise the process by ensuring time limited viewing of images and the standardisation of the size and resolution of images. There is however no consensus in the literature currently, whether the photographs of teeth should be viewed as life-sized or magnified.

The examiners described how they spent time deliberating over the interpretation and scoring of questionable carious lesions. While some examiners saw the ability to view the intra-oral photographs again at a later time as an opportunity to affirm their diagnosis (an opportunity not available with the visual examination method) others felt it extended the time for indecision. This could be mitigated by time limited access to photographs (Langer *et al.*, 2006).

The accompanying paperwork for recording diagnostic decisions was seen by the examiners as exacerbating the duration for viewing photographs and they felt this could be reduced by preparing the paperwork prior to the photographic assessments and the use of a scribe as occurs when undertaking the visual examination method. This may reduce the potential cost savings of using the photographic method. Alternatively an electronic on screen recording system synchronised to the images could be developed.

The examiners reported experiencing more difficulty interpreting and scoring photographs of the permanent teeth than those of the primary teeth, similar to the findings in other studies. Costa *et al.* (2007) found that diagnostic methods for occlusal caries were more efficient in primary teeth than permanent teeth.

The examiners also expressed experiencing problems associated with identifying the presence of tooth coloured restorations, clear fissure sealants and non-carious lesions and attributed this to the lack of tactile sensation. Bader *et al.* (2001) found no evidence to suggest the superiority of tactile methods. Factors which obscured the tooth surface such as saliva, food debris, plaque and stains were problematic. Some of these factors can be more easily eradicated in the visual examination method; however any moisture or debris that remains on the tooth when the intra-oral photograph is captured is in effect a permanent obstruction which will always impair caries detection from that image. Moisture control in children can however be challenging (Tran and Messer, 2003) and even more so when obtaining intra-oral photographs. In the view of the examiners, using more efficient means of moisture control such as compressed air when obtaining intra-oral photographs rather than using cotton wool rolls as stipulated for use in the visual examination method developed by BASCD will improve their utility. The use of a camera with an inbuilt drying nozzle could also assist.

The use of the photographic method could support epidemiological surveys as part of the training, calibration and data collection processes. It allows multiple examiners to inspect a tooth without the difficulties often encountered when a child experiences multiple examinations. Participants identified that this feature will lend itself to e-learning training and calibrating examiners in caries epidemiology skills remotely or by convening. Examination of archived intra-oral photographs in a longitudinal study of caries progression was identified as

more likely to allow accurate and reliable comparisons than the comparisons of visual and written records.

As the debate continues about the level at which caries should be recorded in dental epidemiology surveys there is increasing support for the use of intra-oral photographs in this field (Elfrink *et al.*, 2009). The examiners in this study were optimistic about the possible use of the photographic method for remote training and calibration of examiners in epidemiological skills with improved utility.

Conclusion

The views of examiners in this study suggest that to improve the utility of photographic method, further research is needed to determine adequate drying methods for use in the field. Consideration should be given to a time-limited, standardised presentation of the photographs including the size and resolution. Specific training on caries detection from photographs is also required.

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