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ORIGINAL ARTICLE

Reliability of intra-oral camera using teledentistry in screening of oral diseases – Pilot study

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Abstract *Objective:* Reliability of intra-oral camera using teledentistry in screening of oral diseases.

Methodology: A trained and calibrated examiner used intra-oral camera to capture videos of oral cavity along with clinical examination to evaluate caries, plaque, calculus, tooth wear and fluorosis, stains in children.

Results: The mean DT and DMFT were significantly higher with use of intra-oral camera than with clinical examination ($p = 0.001$ and 0.001) respectively. A positive strong significant correlation was seen between intra-oral camera and clinical examination with respect to DT, MT, FT and DMFT ($r = 0.721$, $p < 0.001$; $r = 0.908$, $p < 0.001$; $r = 0.869$, $p < 0.001$; $r = 0.876$, $p < 0.001$) respectively. Reliability of intra-oral camera when compared with clinical examination varied from substantial to almost perfect agreement various oral conditions. Disclosed immature plaque was not clear while mature plaque was clearly demonstrated.

Conclusion/recommendations: Intra-oral camera was shown to be a reliable tool to identify common oral diseases. Further studies involving applications like sealant retention, pre-malignant lesions, recurrent apthae, gingival recession and dental malocclusion and effectiveness in regular screening are needed.

1. Introduction

Dental caries is a preventable and treatable oral condition that remains the most common chronic diseases among children (Kopycka-Kedzierawski et al., 2008) followed by gingivitis, both of which are mainly caused by dental plaque. Regular screening of children would help in early detection and possible prevention for these dental plaque related diseases. Other common oral conditions seen in children are calculus,

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gingivitis, fluorosis, dental trauma, eruption gingivitis, pulp polyps, tooth wear.

However, regular screening may not be possible due to limited resources in the form of manpower and money. A simple approach is to train the school teachers to screen the children at regular intervals. Screening may be feasible but requires a lot of effort, resources and time to train teachers by clinicians. Eventually a decision for the treatment can be made only by the clinician. Regular screening by a dental professional is also not feasible keeping in mind with the financial and time constraints.

To overcome this problem, we proposed to screen the oral cavity of children with the help of intra-oral camera. Intra-oral camera is a small hand held device which has a lens which can be focused to view the oral cavity. Dentistry, in a synergistic combination with telecommunications technology and the internet, has yielded a relatively new and exciting field that has endless potential called as "Teledentistry" (Sukhabogi et al., 2014). Cook in 1997 defined it as "the practice of using video-conferencing technologies to diagnose and to provide advice about the treatment over a distance" (Yoshinaga, 2001).

Teleconsultation through teledentistry can take place in either of the following way-"Real Time Consultation" and "Store and Forward Method" (Jampani et al., 2011). Few other techniques which were discussed in the literature were "Remote Monitoring Method" and "Near Real Time consultation" (Birnbach, 2000).

Teledentistry for screening caries was shown to be reliable tool in previous studies (Kopycka-Kedzierawski and Billings, 2006; Kopycka-Kedzierawski et al., 2007, 2008). Teledentistry was also used to evaluate the interceptive orthodontic services provided to disadvantaged children (Berndt et al., 2008), orthodontic referrals (Stephans et al., 2002; Mandall et al., 2005), dental prosthetics and oral rehabilitation consultations (Ignatius et al., 2010), diagnosis and management of impacted 3rd molars (Duka et al., 2009; Herce et al., 2011), oral and maxillofacial consultations and treatment planning (Aziz and Ziccardi, 2009), recognition of root canal orifices (Brullmann et al., 2011), periapical bone lesions (Baker et al., 2000), oral lesions (Torres-Pereira et al., 2008) and even follow-up of facial laceration in the emergency department (Walker et al., 2011).

A recent systematic review reported that the majority of teledentistry studies were conducted in the US and there were no studies from developing countries. Most of these reports referred to pilot projects, short-term outcomes, and were descriptive. The review indicated that although teledentistry is an area of expansion with lot of potential, there are still some barriers to its increased use (Mariño and Ghanim, 2013). Owing to this scant data from developing countries, we aimed to evaluate applicability of intraoral camera using teledentistry for comprehensive screening of oral conditions.

2. Methodology

Children visiting urban health centre in the Udupi district of Karnataka state were invited to participate. The procedures, possible risks, and benefits were explained to participants and parents of the participating children. Parental informed consent was obtained prior to the study. The study was approved by the Institutional Ethics Committee of Manipal University, Manipal, India. Children with oral conditions like dental caries, plaque, calculus, stains, tooth wear and fluorosis were invited participate. Only Children who had parental informed consent with the above oral conditions were included in the study. Children with urgent oral treatment (abscess, pain or swelling) were excluded. Eligible children were selected from the out-patient department of the urban health centre over a period of one month.

The teeth were dried with cotton rolls, and the examiner visually examined the teeth using a plane mirror (WHO, 1997). Decayed, missing and filled teeth (DMFT/dmft) were recorded. Similarly, presence or absence of plaque, calculus, stains, tooth wear and fluorosis were also recorded for six upper and lower anterior teeth. A total of 62 subjects participated in the study.

Calibration was done by one gold standard experienced examiner (PKC) as per the guidelines given by WHO (1997). Training sessions were conducted on 10 preselected children with a wide range of oral conditions for a period of 2 days which was followed by calibration on 20 preselected children.

Following the clinical examination, a calibrated dentist performed video recordings of the subject's teeth with the help of intra – oral camera (Swans USB-Intra-Cam, China). Additional images if required were obtained as and when necessary. For study purposes, identifiers were then removed and the images. The intraoral camera was equipped with light emitting diode for illumination. The same source of illumination was used for clinical examination. After a 2-week washout period, the images were read by the same calibrated dental examiner (PM).

The diagnostic quality of the digital images was assessed by comparing the traditional oral examination to the images obtained using the intraoral camera. Validity of the image capture procedure was assessed by visually re-examining children observed to have caries lesions on images that were not observed visually. Conversely, all caries lesions observed on the imaged teeth were also observed visually.

Statistical analysis: All the analysis was done using SPSS version 14 (SPSS Inc, Ill, Chicago, USA). A p-value of <0.05 was considered statistically significant. Clinical and intra-oral camera DMFT/dmft values were evaluated for correlation using Spearman's rho correlation coefficient. Mean DMFT/dmft using clinical and intra-oral camera examination was compared using Wilcoxon signed rank test. Presence or absence of calculus, stains, tooth wear and fluorosis using clinical and intra-oral camera examination was compared using Kappa coefficient. Sensitivity and specificity values for intra-oral camera using teledentistry were calculated.

3. Results

A total of 62 children participated in this study out of which 43 (69.4%) females. The mean age of the children ranged from 10.77 ± 2.58 with a range of 7–16 years (Table 1). The mean DT and DMFT were significantly higher with use of intra-oral camera than with clinical examination ($p = 0.001$ and <0.001) respectively while, no significant difference was seen with respect to mean MT and FT between the two techniques ($p = 0.240$ and 0.063) respectively (Table 2). A positive strong significant correlation was seen between intra-oral camera and clinical examination with respect to DT, MT, FT and DMFT ($r = 0.721$, $p < 0.001$; $r = 0.908$, $p < 0.001$; $r = 0.869$, $p < 0.001$; $r = 0.876$, $p < 0.001$) respectively.

Table 1 Demographic characteristics of the study participants.

Sex	Female *n*(%)	43(69.4%)
	Male *n*(%)	19(30.6%)
Age in years	Mean ± SD (range)	10.77 ± 2.58 (7–16)

The level of agreement between intra-oral camera and clinical examination was 93.55 with Kappa value of 0.714 which indicated that there was substantial agreement. The percentage level of agreement for clinical indices like stains and dental fluorosis were 95.83 and 100% with Kappa coefficient of 0.825 and 1 which suggested that there was almost perfect agreement. Similarly, the percentage level of agreement for clinical indices like tooth wear and calculus were 85.83 ad 93.33% with Kappa coefficient of 0.716 and 0.76 which suggested that there was substantial agreement. The sensitivity and specificity ranged from 90 to 100% and 66.7 to 100% respectively for various oral conditions (Table 3).

4. Discussion

Our study reported that more than 3/4th of the sample size was diagnosed with dental caries with the help of the intra- oral camera. The kappa statistics between digital and traditional clinical examinations for stains and dental fluorosis suggested perfect agreement and for caries, tooth wear and calculus suggested substantial agreement.

The mean DT and DMFT scores with intra-oral camera examinations were significantly higher than with clinical examination while, no significant difference was seen with respect to mean MT and FT between the two techniques. This was similar to a study done using teledentistry with intra-oral camera which reported higher mean decayed teeth/surfaces than traditional oral examinations (Kopycka-Kedzierawski et al., 2007). Teledentistry was shown to be reliable screening method for dental caries in previous studies (Kopycka-Kedzierawski and Billings, 2006; Kopycka-Kedzierawski et al., 2007, 2008). The digital images overestimated caries than the visual examination. This was unusual with the use of intra-oral camera and could have occurred due to possible difference in the diagnostic criteria and examination. Although care was taken to discourage the use of probe during clinical examination, some degree of examination bias could have overestimated the caries. Also, the role of illumination and magnification could not be denied in this overestimation. Teledentistry images offered superior visualisation of the oral cavity than traditional visual examination but can lead to overestimation of the disease levels. Hence, it can be recommended only for preliminary screening after which confirmatory diagnosis should be made clinically.

It was also seen from our study that, intra-oral camera can be reliable screening method for assessment of calculus, stains, tooth wear and dental fluorosis. So far, no previous studies have evaluated the reliability of these conditions. Plaque with disclosing agent was not clearly demonstrable with intra-oral camera which might be due to lower resolution/bright illumination. The intra-oral camera might be further useful in assessing other conditions like pre-malignant lesions, recurrent apthae, gingival recession and dental malocclusion.

Teledentistry can be useful as a potential cost – effective method of screening large masses of the population in rural areas or areas without easy access to dental facilities. A demonstration involving identifying caries, fluorosis, calculus, stains and trauma can effectively train school teachers or

Table 2 Comparison of mean DT, MT, FT and DMFT scores between intra-oral camera and clinical examinations.

	Intra-oral camera		Clinical examination		*p*-value
	Mean	SD	Mean	SD	
DT	2.37	2.41	1.73	1.72	0.001
MT	1.89	3.69	1.77	3.73	0.273
FT	2.19	2.53	1.98	2.43	0.071
DMFT	6.45	4.95	5.48	4.79	0.001

Wilcoxon signed rank test.

Table 3 Comparison of sensitivity, specificity, percentage agreement, reliability (Kappa-coefficient) between intra-oral camera and clinical examinations.

			Intra-oral camera		Sensitivity	Specificity	% agreement	Kappa
			Absent	Present				
Clinical	Caries experience	Absent	6	3	98.1	66.7	93.55	0.714
		Present	1	52				
	Tooth wear	Absent	47	11	90.3	81	85.83	0.716
		Present	6	56				
	Fluorosis	Absent	96	0	100	100	100	1
		Present	0	24				
	Stains	Absent	14	4	99	77.8	95.83	0.825
		Present	1	101				
	Calculus	Absent	16	6	98	72.7	93.33	0.76
		Present	2	96				

dental auxiliary to record and transmit the video to dental professionals. It also helps the dental professional to keep a database so that it can be compared with follow-ups, save time, money and the need to travel to remote rural areas and reduces the absence from school or work place for the individuals.

Some potential advantages with the use of intra-oral camera were early diagnosis, images acquired can be sent to expert/specialist opinion, repeatability of images, saves time and resources and enhance access to care for rural and remotely located individuals, to motivate and educate patients on the importance of oral hygiene and specific treatment plans. Unlike telemedicine, treatment cannot be prescribed remotely as the subject needing treatment for oral conditions still needs to visit a dentist which is a major drawback for this technique. Some other limitations with intra-oral camera which were noticed were inability to visualize the distal side of the last molar and immature plaque. Eventually, the use of teledentistry can be a solution to the barriers of dental care like the lack and cost of transportation, time off from work and school and to save the patient's money. Further studies are needed in India to explore the tremendous potential of teledentistry. Existing infra-structure in the dental institutions should promote teledentistry to rural and remote areas to make the individuals more aware about the facilities.

Conflict of interest

We have no conflict of interest to declare.

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