Oral hygiene assessment by school teachers and peer leaders using simplified method

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Abstract:

Background: A significant proportion of children in developing countries are having plaque-induced gingivitis. A public health strategy may involve teachers and peer leaders to motivate and train school children for regular and thorough removal of dental plaque. The monitoring and evaluation of such a strategy may require teachers and peer leaders to assess oral hygiene status of children at periodic intervals.

Objective: To validate the simplified dental examination performed by teachers and peer leaders to detect dental plaque and calculus.

Methodology: This longitudinal study involved 632 adolescents studying in sixteen schools of Karachi, Pakistan. Eight schools each were randomly allocated to the peer-led and teacher-led strategies of examination. One section of class six was selected at random in each school to be included in the study. In each selected section of class six the trained teacher-in-charge or a peer-leader undertook dental examinations at baseline, 6-month and 18-month intervals and their findings were compared with those of a dentist. The outcome measures included the Kappa values for examiner agreement as well as the sensitivity, specificity, positive and negative predictive values.

Results: All teachers and peer leaders showed a substantial degree of agreement (Kappa ≥ 0.8) with the dentist in detecting plaque and calculus at all three examinations. The values of validity measures for teachers' and peer leaders' examination were in the range of 87-90%.

Conclusions: The examinations performed by teachers and peer leaders were reasonably valid to detect plaque and calculus. However, booster training sessions are needed to maintain their performance as dental examiners.

Key words: Validity, teachers, peers, oral examination, dental examination, plaque, calculus.

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Introduction

Traditionally dental examinations in school setting have been performed by dentists. [1] Very few studies have reported on the validity of dental examinations undertaken by personnel other than dentists. [2-6] Most of these studies have shown that non-dentist personnel when used as dental examiners can provide valid data if the criteria for detecting dental disease are clear and appropriate training is provided. A nurse with a little formal dental training has been found to apply the diagnostic criteria adequately. [4] The utilization of school teachers for dental examination of school children is a rare finding in the literature [6] although they have often been involved in school based oral health education. [7-9]

The dental examination in schools is mostly performed using a dental mirror and a metallic probe. The substantial cost of these instruments and the additional cost of their handling and sterilization have resulted in a search for more cost effective, almost equally valid and easy-to-use alternatives for use in field conditions. The authors in two previous studies [10-11] found a simplified method of dental examination using wooden tongue blade and tooth pick (TT examination) almost comparable to the conventional dental mirror and probe examination (MP examination) for detecting cavitated carious lesions, dental plaque, gingival bleeding and calculus. In those studies both the MP and TT examinations were performed by a dentist. Considering the simplicity of the methods and criteria employed in TT examination, it was hypothesized that this type of examination could be performed by trained teachers and peer leaders with almost the same degree of validity that could be achieved if it was undertaken by a dentist.

The present study was conducted to validate the simplified dental examination performed by trained teachers and peer leaders to detect dental plaque and calculus against simplified examination undertaken by a dentist.

Methods:

Study subjects:

The study was conducted as part of a preventive oral health care project in Karachi, Pakistan and involved 632 adolescents studying in sixteen secondary schools having a mean age of 10.4 years at the start of the study. Eight of the selected schools belonged to the category of public schools and the other eight were private schools. Four of the schools in each category were boys' and the other four were girls' schools. Two schools each from the selected boys' and girls' public and private schools were assigned at random to the peer-led (PL) and teacher-led (TL) strategies of oral examination by a non-participating teacher using a lottery method. All selected schools had more than two sections in class six. One section of class six was selected at random in each school giving a total of sixteen sections of class six included in the study. None of the children in the selected schools was excluded from examination based on the exclusion criteria adopted for the study that included presence of toothache, difficulty opening mouth, fixed orthodontic appliances or some serious systemic disease. The parents of all children participating in the study gave a positive informed consent. The children were given a detailed report about their dental status to take home at the end of each examination with the option of seeking dental care at the two university hospital clinics at subsidized rates. The ethical approval for the study was sought from the Institutional Review Board of Shaikh Zayed Medical Complex, Lahore (Ref. No. SZH/IRB/017-03).

Selection of teachers, peers and dentist as examiners:

In schools with teacher-led strategy of oral examination, the teacher-in-charge of every selected section of class six was assigned the responsibility of examination while in those with peer-led strategy one student in each section of class six was chosen by the teacher-in-charge to act as examiner. A community dentist who had previously been trained and calibrated for the TT examination [10-11] was used as the bench mark examiner.

Study design: The study followed a longitudinal design and involved three examinations (Exams I, II, and III) of the study subjects. There was an interval of about six months between first and second examinations followed by a period of about a year before the third examination.

Examination Procedure: The study subjects were examined under natural light firstly by teacher/ peer leader of the respective section of class six and then by the dentist, all using a wooden tongue blade and a toothpick for examination.

The examiners' and subjects' position as well the examining conditions were standardized. Tongue blade was used to retract cheeks, lips and tongue, and tooth pick to confirm the presence of visible plaque and calculus. Tongue blades and toothpicks were used as disposables.

The labial/ buccal and lingual/ palatal surfaces of index teeth (the two central incisors and the two most posterior teeth on the right and left sides of the upper and lower dental arches) were examined in a standardized sequential order in all subjects. The findings were recorded on a specially designed form. The oral hygiene codes for labial/ buccal and lingual/ palatal surfaces were recorded in separate sets of boxes. The time taken per examination by all examiners was in the range of 3-4 minutes. All examinations were performed before lunch break.

Codes and diagnostic criteria:

A dichotomous scale with 'present' and 'absent' categories was used for plaque and calculus which were recorded as present if visible to the naked eye as well as detected by tooth pick. The codes used for recording the findings included '0' for no plaque and calculus, '1' for plaque and '2' for calculus. The worst score for any of the two index teeth in each sextant was recorded.

Training of teachers/ peer leaders: The teachers and peer leaders were trained together by the first author during two sessions of 2-hour duration each. The training involved lectures, slide show, discussion and demonstration during one session; and a practical exercise in the other. In the first session the procedure, codes and criteria for examination were discussed. The author also gave demonstration on five selected children having plaque and calculus. The second session comprised of a practical exercise that included examination of 20 class six children with and without plaque and calculus. The teachers and peer leaders undertook examination of these children in groups of four each (two teachers and two peers) under the direct supervision of the author and recorded the findings. They discussed with the author the findings about which they were not clear. However teachers and peer leaders were not calibrated.

The teachers and peer leaders were given a booster training session a week before Exam III but not before Exam II.

Data analyses:

The inter-examiner reliability of every teacher and peer-leader was determined at the three examinations using the dentist as the benchmark examiner and applying Kappa statistics. A Kappa value of 0.8 for all these individual comparisons was the minimum requirement for comparing teachers and peers as two groups with the dentist during further analysis. The validity measures of teacher- and peer-examination including sensitivity, specificity, positive predictive value, negative predictive value, false positive rate and false negative rate were then estimated for Exams I, II and III using the dentist examination as the standard. Pearson's Chi-square and Student's-t tests were used to find out differences among the study groups with regard to the proportion of children and the mean number of sextants with plaque and calculus. The level of statistical significance set for these differences was $p<0.05$. The data analysis was performed using SPSS 16 program.

Results: The study involved 632 adolescents having a mean age of 10.4 years. All these adolescents remained part of the study till the last examination. Table 1 shows that the teacher- and peer leader-examination groups were almost comparable with regard to the number of children and the mean number of sextants with plaque and calculus at all three examinations with only one exception in which case the peer-leader group had significantly higher percentage of children with calculus than the teacher group at Exam II (Table 2).

The results showed a substantial degree of agreement [12] of all teachers and peers with the dentist in detecting plaque and calculus at all three examinations (Kappa ≥ 0.8) (Table 3). In plaque examination a slight decrease in Kappa values was noted in the majority of cases at Exam II as compared to the values at examination I in both teacher- and peer leader-

groups but the Exam III scores of both groups showed an improvement over the respective scores at the two previous examinations in all cases. Exactly half of the teachers (examiner 1, 2, 3 and 4) and peer leaders (examiner 9, 13, 14 and 16) experienced a slight decrease in their Kappa values in calculus examination at Exam II as compared to the values at Exam I while the rest of the examiners in the two groups showed an improvement in their Exam II Kappa values over the corresponding values at Exam I (Table 3). The Kappa scores of four teachers (examiner 4, 6, 7 and 8) for calculus deteriorated at Exam III when compared with the respective scores at Exam I while for the other four teachers (examiner 1, 2, 3 and 5), Exam III scores were better than the scores at Exam I. A decrease in the Kappa scores of three teachers (examiner 6, 7, and 8) for calculus was noticed at Exam III compared to their scores at Exam II but the reverse was true for the calculus scores of the other five teachers (examiner 1, 2, 3, 4 and 5). All examiners in the peer-leader group had higher Kappa scores for calculus at Exam III than their scores at Exam I and II except two examiners (examiner 13 and 16) whose Exam III scores were comparatively lower than their previous two scores.

It can be observed in Table 4 that the teachers and peer leaders had almost comparable Kappa scores for plaque and calculus. The Kappa scores of the two groups were found to be higher for calculus than those for plaque at all three examinations. The two groups exhibited slightly lower Kappa scores for plaque as well as for calculus at Exam II than those at Exam I but the Exam III scores of the two groups were substantially higher than their Exam I and II scores.

Table 5 shows that the sensitivity, specificity, positive predictive and negative predictive values of simplified examination performed by teachers and peer leaders for detection of plaque and calculus were either close to or greater than ninety percent at all three examinations with the exception of the negative predictive value for plaque at Exam II which was about eighty seven percent for both teacher and peer leader groups. All these validity measures had nearly comparable values at Exam I and II. However the values at Exam III by and large showed an improvement over the values at the two previous examinations. The false positive rate for dental plaque in both teacher and pear leader groups being in the range of about 7-8% at Exam I and II decreased to about 1-3% at Exam III. The values of the false negative rate of the two groups, however, remained between 6-7% in all three examinations for dental plaque. The false positive rates of teacher- and peer-leader examinations for dental calculus were reasonably low (about 0.2-2.0%) at all three examinations but the false negative rate for calculus in the two examiner groups showed a substantial decrease from about 7-9% at Exam I and II to about 2-3% at Exam III.

Table (1). Distribution of the study subjects: gender and type of school

Strategy	School	Gender		
		Male (No. & %)	Female (No. & %)	Total (No. & %)
Teachers	Public	69 (44.8)	85 (55.2)	154 (50.2)
	Private	76 (49.7)	77 (50.3)	153 (49.8)
	Total	145 (47.2)	162 (52.8)	307
Peer leaders	Public	81 (47.6)	89 (52.4)	170 (52.3)
	Private	72 (46.5)	83 (53.5)	155 (47.7)
	Total (No. & %)	153 (47.1)	172 (52.9)	325(100.0)

Table (2). Descriptive Statistics*

Strategy		Examination	No. of subjects (%)	Mean No. of sextants (SD†)
Teachers	Plaque	I	281 (91.5)	7.88 (3.76)
		II	279 (90.9)	8.21 (3.32)
		III	270 (87.9)	5.69 (3.37)
	Calculus	I	132 (43.0)	0.81 (1.37)
		II	152 (49.5)‡	0.98 (1.53)
		III	200 (65.1)	1.63 (1.96)
Peer leaders	Plaque	I	288 (88.6)	7.38 (3.73)
		II	313 (96.3)	8.10 (3.12)
		III	300 (92.3)	5.59 (3.30)
	Calculus	I	140 (43.1)	0.84 (1.36)
		II	183 (56.3)‡	1.20 (1.65)
		III	201 (61.8)	1.55 (1.94)

*Outcome of examination performed by the dentist using dental mirror and probe.

†SD: Standard deviation.

‡Statistically significant difference (p =0.035).

Total number of children examined: 632

Number of children examined by teachers: 307

Number of children examined by peer leaders: 325

Total number of sextants: 7584

Number of sextants per child: 12, buccal/ labial: 6 and lingual/ palatal : 6

Table (3). Inter-examiner reliability (Kappa values) of Teacher/ Peer leader vs. dentist Examination

Strategy	Examiner	Plaque			Calculus		
		Exam I	Exam II	Exam III	Exam I	Exam II	Exam III
Teachers	1	0.841	0.800	0.899	0.922	0.918	0.963
	2	0.860	0.850	0.915	0.928	0.923	0.972
	3	0.878	0.817	0.888	0.935	0.925	0.957
	4	0.880	0.811	0.894	0.970	0.871	0.898
	5	0.864	0.838	0.913	0.942	0.949	0.954
	6	0.805	0.812	0.914	0.951	0.964	0.950
	7	0.883	0.852	0.914	0.946	0.950	0.931
	8	0.893	0.875	0.901	0.920	0.954	0.909
Peer leaders	9	0.872	0.825	0.932	0.913	0.870	0.963
	10	0.862	0.851	0.911	0.897	0.910	0.941
	11	0.800	0.832	0.908	0.902	0.910	0.931
	12	0.837	0.843	0.915	0.879	0.892	0.960
	13	0.903	0.873	0.950	0.966	0.919	0.906
	14	0.820	0.845	0.921	0.958	0.953	0.967
	15	0.890	0.832	0.942	0.924	0.947	0.968
	16	0.867	0.825	0.907	0.954	0.915	0.904

Table (4). Dentist vs. teachers/ peer leaders : Sextants with and without dental plaque and calculus (n=7584)

	Exam I				Exam II				Exam III			
Plaque	Dentist				Dentist				Dentist			
Teachers	Present	Absent	Total	kappa	Present	Absent	Total	kappa	Present	Absent	Total	kappa
Present	2155	95	2250		2276	103	2379		1605	48	1653	
Absent	133	1301	1434	0.869	169	1136	1305	0.837	119	1912	2031	0.903
Total	2288	1396	3684		2445	1239	3684		1724	1960	3684	
Peer leaders												
Present	2242	104	2346		2390	101	2491		1670	38	1708	
Absent	160	1394	1554	0.858	179	1230	1409	0.842	110	2082	2192	0.923
Total	2402	1498	3900		2569	1331	3900		1780	2120	3900	
Calculus												
Teachers												
Present	196	8	204		262	16	278		449	34	483	
Absent	18	3462	3480	0.935	20	3386	3406	0.930	10	3191	3201	0.946
Total	214	3470	3684		282	3402	3684		459	3225	3684	
Peer leaders												
Present	250	17	267		337	32	369		464	33	497	
Absent	24	3609	3633	0.919	25	3506	3531	0.914	13	3390	3403	0.946
Total	274	3626	3900		362	3538	3900		477	3423	3900	

n: Total number of sextants
Number of sextants per child: 12; buccal/ labial: 6 and lingual/ palatal: 6
Total number of children examined: 632
Number of children examined by teachers: 307
Number of children examined by peer leaders: 325

Table (5). Validity measures of Teachers'/ Peer leaders' examination

	Exam 1		Exam 2		Exam 3	
Plaque	Teacher-led	Pear-led	Teacher-led	Pear-led	Teacher-led	Pear-led
Sensitivity %	94.19	93.34	93.08	93.03	93.10	93.82
Specificity %	93.19	93.06	91.69	92.41	97.55	98.21
+ ve Predictive value %	95.78	95.57	95.67	95.95	97.10	97.78
- ve Predictive value %	90.73	89.70	87.05	87.3	94.14	94.98
False + ve Rate %	6.81	6.94	8.31	7.59	2.45	1.79
False - ve Rate %	5.81	6.66	6.91	6.97	6.90	6.18
Calculus						
Sensitivity %	91.59	91.24	92.91	93.09	97.82	97.27
Specificity %	99.77	99.53	99.53	99.10	98.95	99.04
+ ve Predictive value %	96.08	93.63	94.24	91.33	92.96	93.36
- ve Predictive value %	99.48	99.34	99.41	99.29	99.68	99.62
False + ve Rate %	0.23	0.47	0.47	0.90	1.05	0.96
False - ve Rate %	8.41	8.76	7.09	6.91	2.18	2.73

Discussion

A significant proportion of adolescents in developing countries are having dental plaque, plaque-induced gingivitis and calculus. [13-14] There is convincing evidence to show that dental plaque can be effectively removed by thorough tooth brushing on a daily basis thereby preventing plaque-induced gingivitis. [15-16] Dental calculus requires professional scaling for its removal but it does not play a direct role in the etiology of periodontal disease provided its surface can be kept free of plaque. It has been shown that tooth brushing when performed by motivated and instructed individuals can result in improvement of gingival health despite the presence of supra- and sub-gingival calculus.[17] The possible explanation may be that the removal of plaque lying on the supra-gingival calculus by normal tooth brushing results in retraction of initially swollen and inflamed gingival margins. This in turn exposes the plaque present on the sub-gingival calculus to be removed by tooth brush. A public health strategy to improve the gingival health of school children may therefore include motivation and training of these children for regular and thorough removal of dental plaque. The monitoring and evaluation of such a strategy may need an assessment of oral hygiene status of children at periodic intervals which can also be used as a tool for children's motivation. A previous study by Kallio et al has demonstrated the value of self-assessment by adolescents in improving their awareness about gingivitis and gingival health status.[18] The self assessment by adolescents included identification of gingival bleeding after brushing and inter-proximal cleaning with tooth picks as well as the use of a disclosing dye to indicate the residual plaque. In a school setting the assessment of oral hygiene status by trained teachers and peer leaders may enhance the acceptability, accessibility and cost-effectiveness of a strategy for improvement of gingival health of children.

The present study was conducted to validate the dental examination performed by teachers and peer leaders to detect dental plaque and calculus. The validation of teacher- and peer leader-examination findings against those of dentist's examination yielded very high values of sensitivity, specificity, positive predictive and negative predictive values for both plaque and calculus. The sensitivity of teacher- and peer leader-examination for calculus was somewhat lower than that for plaque. Nevertheless based on the premise of preventing gingivitis by plaque control even in the presence of calculus, the higher sensitivity for plaque detection makes teacher- and peer leader-examination a sensible choice for school setting. In the present study the teachers and peers had a substantial agreement with the dentist while detecting plaque and calculus. The finding of the study that the agreement, especially for dental plaque, was markedly improved at the third examination as compared to that at the second examination shows the importance of booster training session which was taken before third examination but not before second examination.

An electronic search through MEDLINE did not reveal any study that reported detection of plaque and/or calculus by teachers or peer leaders. The only study that included six teachers performing visual examination for detecting dental caries was reported by Hecksher et al [6] from an area with high prevalence of dental caries. Each teacher examined her own class students under natural light using a tongue blade. The findings of teachers' examination were compared with those of the researcher dentist and a dental assistant undertaking visual examination under the same conditions. The agreement between observers when determined by kappa statistics gave a value of 0.73 for teachers. The sensitivity for teachers' examination was 76.0%, the specificity 96.2%, the positive predictive value 77.9% and negative predictive value 95.9%. In that study the specificity of teachers' examination for caries was found to be at par with the findings of the present study for plaque and calculus. However the sensitivity and the kappa values for teachers' examination were markedly lower than those achieved in the study under discussion. In the present study the teachers and peer leaders also detected cavitated carious lesions but since the prevalence of dental caries was found to be very low in the study subjects throughout the course of the study, the findings are not being reported here.

The findings of the present study are potentiated by a previous study that involved a nurse to undertake visual examination for dental caries using a portable chair, flash light and a tongue blade. The nurse had no previous dental experience and merely attended a five-hour training session before doing dental examination. The results of the nurse's examination when compared with the findings of visual-tactile examination performed by a dentist yielded values of sensitivity, specificity, positive predictive value and negative predictive values as 92.9%, 99.3%, 98.6% and 95.9% respectively for untreated dental caries which are almost similar to the ones obtained for dental plaque and calculus in the present study. [4]

Despite the impressive results, the applicability of the findings of the present study should be viewed in the context that the objective of the study was to evaluate the ability of teachers and peer leaders to detect plaque and calculus for motivation and monitoring of school children as part of an oral health education program. The aim was not to validate teacher-/peer-examination to provide epidemiological data or to perform screening. The study provided a convincing evidence for validity of dental examination performed by teachers and peer leaders to be used as a motivational tool during school-based oral health education.

Conclusion

The dental examination performed by teachers and peer leaders was found to be reasonably valid for detecting plaque and calculus. However the study highlighted the importance of booster training sessions in maintaining the performance of teachers and peer leaders as dental examiners.

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