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2001

http://hdl.handle.net/10539/20264

Cleaton-Jones, P., Daya, N., Hargreaves, J. A. et al. Examiner performance with visual, probing and FOTI caries diagnosis in the primary dentition. South African dental journal; 56 (4):182-185

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Examiner performance with visual, probing and FOTI caries diagnosis in the primary dentition

Keywords: dental epidemiology, dental caries diagnosis

SUMMARY

To compare clinical reproducibility of dental caries diagnosis in the primary dentition under field conditions, a convenience sample of 5-year-old children in a nursery school in Germiston, was examined for dental caries by four dentists using visual (mirror), visual plus tactile (mirror plus probe) and fibre-optic transillumination (FOTI) methods. Seventeen children were examined on day one and 11 re-examined on day two. Inter-examiner agreement was high, above 90%. Visual examination on its own is comparable with the traditional visual plus tactile method and to FOTI under field conditions. New caries data collected by visual diagnosis alone may, reasonably, be compared with historical data diagnosed with visual + tactile examination.

S Afr Dent J 2001; **56**: 182-185

OPSOMMING

Vier tandartse het die kliniese herhaalbaarheid van tandkariesdiagnose in die primêre tandstelsel onder veldtoestande in 'n geriefsmonster van 5-jariges in kleuterskole in Germiston bepaal. Visuele (spieël), visuele plus sondering, en veseloptiese transilluminasie (FOTI) metodes is gebruik. Op die eerste dag is 17 kinders ondersoek van wie 11 op die tweede dag weer ondersoek is. Interondersoeker ooreenkoms was hoog, bo 90%. Afsonderlik is visuele ondersoek vergelykbaar met die tradisionele visuele plus sonderingmetode en FOTI in die veld. Nuwe karies data wat slegs deur visuele diagnose verkry is, mag redelik met die historiese visuele plus sonderingdata vergelyk word.

It is not clear when dental caries was first diagnosed with a mirror and sharp probe but the method was used in 1910 when Friel published the results of the first field study of the disease in South Africa. Until recently, South African researchers as well as their North American colleagues continued to use the method (Roberts *et al.*, 1993; Disney *et al.*, 1992). There has been pressure for some time, however, from British and European dental epidemiologists to use visual diagnosis alone, possibly with fibre-optic transillumination (FOTI), because of a potential to damage tooth structure or to transfer cariogenic bacterial strains with a sharp probe (Pitts and Evans, 1996). To change from visual plus tactile examination to visual only is easy but if this is done, may new field data be compared with the large amount of accumulated information in South Africa since 1910?

The objective of the current study was to compare dental caries diagnoses made under typical survey conditions by four clinicians using three diagnostic methods.

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Materials and methods

Population

The study sample was all the 5-year-old children present on two study days in a nursery school, one of

15 such schools in Germiston that have participated in a caries surveillance study since 1981, so staff have become accustomed to dental surveys (Cleaton-Jones and Williams, 1995). Ethical clearance was obtained from the University of the Witwatersrand and all the parents gave informed consent before the children were examined. Each child gave verbal consent to be examined.

Examiners

Three of the examiners had been calibrated for visual plus tactile examination by examining some 200 extracted permanent teeth embedded in groups of five in plaster blocks on two occasions to kappa scores >0.8 (Cleaton-Jones *et al.*, 1989). One examiner was highly experienced in caries diagnosis with FOTI, having participated in international clinical trials using the method. With FOTI, dental caries is diagnosed when there is a clear dentinal shadow within a tooth. All four examiners had completed an extensive comparison of the same three diagnostic methods, plus radiographs, on extracted permanent teeth mounted in training mannikins two days before the current study.

Examinations

On day one the primary teeth of all 17 5-year-olds in the school were examined indoors in good, mixed natural and artificial light. Two examiners did visual diagnosis only with a plane mirror (V1, V2), one did visual plus tactile with a plane mirror and sharp probe (VP), and one used FOTI with a 0.5 mm diameter tip. No radiographs were used for ethical reasons. Each child had four examinations, one by each examiner each day. On the second day 11 of the original 17 children, were re-examined in the same way. Earlier WHO dental caries diagnostic criteria that specified the use of a probe (WHO, 1987) were used for VP and current WHO criteria which recommend a mirror only (WHO, 1997) were used for V1, V2. Both of these criteria specify that obvious cavitation is the minimum requirement for diagnosis; 'white spots' or 'sticky fissures' were not diagnosed as dental caries. FOTI used dentinal shadows - the FOTI tip was placed on all erupted tooth surfaces and a plane mirror was used to look for dentinal shadows within a tooth (Côrtes *et al.*, 1994). Missing teeth were not included in the scoring.

Statistical analysis

A possible total of 11 918 surface observations were available for analysis with SAS (1990), variations in numbers of surfaces examined by each examiner was due to a child having to go home with a parent before completion of the examination, or a disagreement between examiners on whether a tooth was from the primary or permanent dentition. Each tooth surface was classified as sound (S) or unsound (U) to produce patterns of agreement (SSSS, UUUU) or disagreement (SSSU, SSUU, SUUU) between all four examiners. Kappa (Fleiss *et al.*, 1979) and the Modified Percentage Reproducibility [MPR] (Shaw and Murray, 1975) were calculated. The chi-square and NcNemar tests were used with statistical significance set at $P<0.05$.

Results

In the results replicate 1 refers to the results of all 17 children seen on day one, replicate 2 results are for the 11 children seen on day two and replicate 12 indicates the observations on day one for the 11 children who were also seen on day two. The numbers and percentages of tooth surfaces diagnosed as carious are shown in Table I. The percentage of carious surfaces ranged between 2.0 and 6.4; the lowest rates were for visual diagnosis and the highest was with FOTI. Except for V2, between replicates 12 and 2, there were no statistically significant differences between the replicates. Similarly, there were no statistically significant differences between V1, V2 and VP for replicates 1 and 12 but these differed significantly in replicate 2 ($P<0.001$) due to under-diagnosis by V2 in replicate 2. V1 and VP did not differ significantly from each other in any replicate. When FOTI was included in the analyses this differed significantly from the other methods in all three replicates ($P<0.001$).

***Table I.* Dental caries surface prevalence rates by examiner method**

	V1	V2	VP	FOTI
Replicate 1 (n = 17)				
Total surfaces	1 564	1 565	1 618	1 476
Carious surfaces	53	53	72	93
%	34	3.4	4.4	6.3
Replicate 12 (n=11)				
Total surfaces	1 388	1 392	1 442	1 044
Carious surfaces	46	48	49	67
%	3.3	3.4	3.4	6.4
Replicate 2 (n=11)				
Total surfaces	1 388	1 391	1 442	1 044
Carious surfaces	46	28	49	61
%	3.3	2.0	3.4	5.8

*Variation in total surface number is due to surfaces excluded from examination at a replicate.

The inter-examiner agreements and disagreements for tooth surfaces are shown in Table II. Agreement frequency was high in all replicates. Kappa scores were high for three of the four examiners, and the MPR results were above 90% (Table III) but intra-examiner

comparison showed that V2 had a statistically significant difference for surface diagnoses between replicates 12 and 2 ($P<0.05$). No other intra-examiner comparisons showed statistically significant differences.

Table II. Inter-examiner agreements and disagreements for tooth surfaces

		Replicate 1		Replicate 12		Replicate 2	
Children	N	17		11		11	
Tooth surfaces	N	1437		917		956	
		N	%	N	%	N	%
Agreements							
SSSS		1292	89.9	816	89.0	859	89.9
UUUU		14	1.0	10	1.1	10	1.0
Total		1306	90.9	826	90.1	869	90.9
Disagreements							
SSSU		35	2.4	22	2.4	28	2.9
SSUU		21	1.5	15	1.6	20	2.1
SUUU		75	5.2	54	5.9	39	4.1
Total		131	9.1	91	9.9	87	9.1

Table III. Intra-examiner reproducibility scores for tooth surfaces by examiner method

	V1	V2	Vp	FOTI
Kappa	0.88	0.52	0.75	0.74
MPR (%)	99.2	97.8	91.1	97.1
McNemar test ($\square^2$)	0.36	4.12*	2.56	0.75

* = $P < 0.05$, MPR = modified percentage reproducibility

Discussion

The study was trouble free, all children enjoyed the experience. The sample size was limited by logistics. Firstly, the study was done at the end of a school year so attendance was down as families prepared for the summer vacation, secondly the FOTI examiner with her equipment was in South Africa for only a short period. Fortunately, the low number of children was offset by the large number of surfaces examined.

The study design needs some clarification. To fully test the effect of four examiners and three methods each child would have had to be examined 24 times, 12 times each day. It was not ethically acceptable to us to subject the children to so many examinations, hence the current study design which limited examinations to four per day. FOTI was used by a dentist who had been calibrated by international experts, VP was used by an epidemiologist experienced in the technique. Visual only diagnosis was used by two examiners, one (V1) a new graduate, the other (V2) an experienced epidemiologist, since this is the current method recommended (WHO, 1997). Analysis therefore included a combined effect of examiner and method.

For credibility in a study such as this the caries rates of the study sample should be representative of those in the area. The caries prevalence of the 17 children was 59.5% and the mean dfs was 3.1 (upper 95% confidence limit 4.9). Comparable values for 200 5-year-olds in 15 nursery schools in the surveillance study one year earlier were prevalence 51.4% and mean dfs 2.4 (upper 95% confidence limit 4.7), which confirms the representativeness of the sample.

The study does not truly differentiate between diagnostic methods – for that each examiner would need to use each method on the same subject. Rather, it is an inter- and intra-examiner comparison of examiners who used various diagnostic methods. There is no generally accepted 'gold standard' for diagnostic reproducibility but two methods are mentioned by WHO (1997) namely kappa and percentage reproducibility. For kappa > 0.8 indicates good agreement (V1 in this study), 0.6 - 0.8 substantial agreement (VP and FOTI) and 0.4 - 0.6 moderate agreement (V2) (WHO, 1997). For MPR the value that has been recommended by WHO is 85-95% (WHO, 1987). All examiners were above this. The reproducibility values in the current study were higher than a comparable study in the permanent dentition (Côrtes *et al.*, 1994). In that study, as in the current investigation, decisions have to be made that surfaces are sound or carious, and the proportion of carious surfaces present will therefore influence the measured reproducibility. In the study sample the proportion of carious surfaces was low but was representative of the caries rate in the area. The significant difference found for examiner V2 with the McNemar test indicated a slight asymmetry through under-diagnosis of caries on day two. Of the two methods to measure reproducibility kappa is strict and the Modified Percentage Reproducibility is lenient. Current WHO oral health survey methods (1997) recommend the kappa score.

The high agreements in diagnosis between the examiners indicate that if only visual diagnosis is used in future in South Africa, comparison to the mass of accumulated caries data diagnosed by the visual and tactile method will be reasonable.

Conclusion

Regarding choice of diagnostic method for field studies in the primary dentition, the levels of agreement between examiners indicate that all are acceptable. Regarding carious surface rate, FOTI showed the highest rates and visual diagnosis was the lowest.

Acknowledgements

We gratefully record the generous assistance of Unilever Dental Research that provided the FOTI equipment plus researcher (DFC).

This paper is dedicated to the memory of John Anthony Hargreaves, Emeritus Professor at the University of Alberta, Canada and Visiting Professor at the University of the Witwatersrand, and his wife Vera who both passed away before completion of the manuscript.

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ABSTRACT FROM OTHER JOURNALS

Shear bond strength, microleakage and confocal studies of 4 amalgam alloy bonding agents

Objective: This study was undertaken to determine the relative shear bond strengths and microleakage of 4 bonding agents to dentin and amalgam and to investigate the bonding to dentin through confocal laser scanning microscopy.

Methods and materials: Sixty non-carious molars were restored with 1 of 4 different systems and the shear bond strengths were determined. For the microleakage study, Class V amalgam restorations were placed in 60 non-carious teeth. The specimens were thermocycled, the teeth were sectioned and dye penetration was assessed. For confocal examinations, the first component of the bonding adhesives was labelled with rhodamine B. each of the adhesives was applied to 3 dentin specimens, which were examined under a confocal laser scanning microscope.

Results: Of the 4 restorative systems tested, AmalgamBond Plus + HPA and Prime & Bond 2.1/base-catalyst showed significantly higher shear bond strengths. Prime & Bond 2.1/base-catalyst had the lowest microleakage value, which was significantly lower than that of AmalgamBond Plus + HPA and AmalgamBond Plus. AmalgamBond Plus + HPA had the highest variation in both the bond strength and microleakage values. Confocal laser scanning microscopy revealed tag formation, penetration of the bonding agents deep into the tubules, and hybrid layer formation for all 4 bonding systems.

Conclusion: The 2 best systems, Prime & Bond 2.1/base-catalyst and, to a lesser extent, AmalgamBond Plus + HPA, utilised a supplemental bonding agent.

Grobler SR, Oberholzer TG, Rossouw RJ, Grobler-Rabie A & Van Wyk Kotze TJ

Quintessence Int 2000; **31:** *501-508*