

## A follow-up study on three caries activity tests

Sizhen Shi\* / Qing Deng\*\* / Yoshihiro Hayashi\*\*\* / Masashi Yakushiji,\*\*\*\* / Yukio Machida\*\*\*\*\* / Qin Liang\*\*\*\*\*

*The purpose of this research was to study the efficacy of three CAT's (Dentocult SM, Dentocult LB and Dentobuff Strip) in revealing caries condition and predicting caries progress, and provide a reference for application by comparing the three tests. Oral condition and results of the three CAT's of 82 children aged 3 to 4 were recorded and followed up. The examination was checked again two years later. The caries incidence, dft and CSI data from the two examinations were analyzed statistically. The results were that each Dentocult SM degree showed significant variances in incidence rate, as did the dft and CSI results in the second examination. The dft and CSI of both examinations exhibited a high degree of statistical significance. The same may be said of the Dentocult LB findings for the two years. No noticeable variances in caries incidence rate, dft and CSI from the Dentobuff Strip test were observed in both years' study, nor was there any statistical significance drawn from the findings, except for those of the second exam. No gender differences were observed in the distribution by degree with the three CATs. The conclusion is that Dentocult SM is the best of the three tests for the diagnosis of the presence of caries and prognosis of its progress, Dentocult LB is second best, whereas the Dentobuff Strip shows no detection capability. The findings serve as an application reference.*

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### INTRODUCTION

For decades, much attention and research have been focused on human caries activity and the search for effective detection strategies. However, a method of high sensitivity and reliability still eludes the researcher. Currently, the severity of tooth decay and prominence of caries activity among preschool-age children are causing increased public concern and attention. We have selected three more promising detection methods (Dentocult SM, Dentocult LB, and Dentobuff Strip) for use in examining eighty-two children of pre-school age, with a 2-year

follow-up, to study and analyze the caries activity phenomenon, and to judge the efficacy of the three detection procedures by comparing the performances.

### MATERIALS AND METHODS

Eighty-two children (43 boys, 29 girls), forty-eight 3-year-olds and thirty-four 4-year-olds, were examined, and followed up two years later.

The study and examinations were conducted by experienced physicians and medical staff. Test results from applying the three detection methods (Dentocult SM, Dentocult LB, and Dentobuff Strip) and from the oral examination were recorded, and checked again two years later.

**Oral examination.** Grades of caries were classified as follows: 0, no caries; 0.5, filled tooth; 1, secondary caries, enamel caries or superficial dentin caries; and 2, deep dentin caries, pulp exposed, crown or root remaining.

**Caries activity test.** All test materials used in the study were manufactured by Orion Diagnostics, Finland. Incubator Type III was manufactured by Sonkin, Japan. Examination began from 9:00 to 10:00 a.m. following a fast of more than 1-1/2 hours.

**Dentocult SM detection.** The saliva was scraped off the surface of the tongue with both edges of a test strip ten times. The strip was then placed in a special medium and incubated at 37° for forty-eight hours to develop a *Streptococcus mutans* culture. After incubation, the strip was checked and grades classified according to the

\* Sizhen Shi, DDS, PhD, Tongji University College of Stomatology, Pedodontics Research Institute 2, Lane 158, Damuqiao Road, Suite 402, Shanghai 200032, China.

\*\* Qing Deng, DDS, Tongji University College of Stomatology, Pedodontics Research Institute 2, Lane 158, Damuqiao Road, Suite 402, Shanghai 200032, China.

\*\*\* Yoshihiro Hayashi, DDS, Department of Pedodontics, Tokyo Dental College, 1-2-2 Masago Chibashi, Chibaken, Japan.

\*\*\*\* Yakushiji, DDS, PhD, Department of Pedodontics, Tokyo Dental College, 1-2-2 Masago Chibashi, Chibaken, Japan.

\*\*\*\*\* Yukio Machida, DDS, PhD, Department of Pedodontics, Tokyo Dental College, 1-2-2 Masago Chibashi, Chibaken, Japan.

\*\*\*\*\* Qin Liang, DDS, Tongji University College of Stomatology, Pedodontics Research Institute 2, Lane 158, Damuqiao Road, Suite 402, Shanghai 200032, China.

density of the *Streptococcus mutans* colonies compared with the standard: Grade 0, <10<sup>4</sup> CFU/ml; Grade 1, 10<sup>4</sup>–10<sup>5</sup> CFU/ml; Grade 2, 10<sup>5</sup>–10<sup>6</sup> CFU/ml; Grade 3, > 10<sup>6</sup> CFU/ml.

**Dentocult LB detection.** After the subject chewed on a special paraffin pellet, 3-5 ml of the mixed saliva was collected into a test tube. It was then transferred to a test slide with a low pH medium selected for a lactobacillus culture. Incubated at 37° for four days, the slide was observed and checked for bacterial colonies. Based on the density of the colonies and compared against the standard, the findings were classified into four grades:

Grade 0, 10<sup>3</sup> CFU/ml; Grade 1, 10<sup>4</sup> CFU/ml; Grade 2, 10<sup>5</sup> CFU/ml; and Grade 3, 10<sup>6</sup> CFU/ml.

**Dentobuff Strip detection.** A droplet of the collected saliva mixture was deposited on the test paper covering the yellow area for five minutes, the color change was checked and the Strip degrees were determined by comparing it against the standard color chart:

Degree 1, yellow, pH≤4.0; Degree 2, green, pH 4.5-5.5; Degree 3, deep blue, pH≥6.0. The higher the grade, the stronger the saliva buffer capacity.

**Data Analyses.** All test data was computer-processed using SAS package software. The CSI (caries severity index) was calculated with the following formula:

$$CSI = \frac{\text{Total grades of caries}}{\text{Total number of teeth X 2}} \times 100$$

The data were analyzed by chi-square test, t-test, ANOVA for F-test and SNK comparison for variances. Spearman rank correlation and linear regression were also included.

**RESULTS**

Caries status of the eighty-two children from both examinations is presented in Table 1.

Table 1. Caries status of 82 children

Gender	Examination	Male	Female	Total
Number of cases		43	39	82
Number of caries	Baseline	20	17	37
	Follow-up	28	27	55
Caries incidence	Baseline	46.51	43.59	45.12
	Follow-up	65.12	69.23	67.07
dft x±s	Baseline	1.44±2.32	1.62±3.05	1.52±2.68
	Follow-up	2.32 ± 2.75	2.95 ± 3.78	2.62 ± 3.27
CSI x±s	Baseline	4.22±7.62	4.21±8.68	4.21±8.09
	Follow-up	6.47±9.35	8.17± 13.83	7.28±11.65

No gender variance in caries incidence, dft or CSI was found in both examinations. The statistical findings were: x<sup>2</sup> = 0.07, t = 0.29, t = 0.004 (p>0.05) in the baseline examination, and x<sup>2</sup> = 0.16, t = 0.65, t = 0.52 (p>0.05) in the second examination.

Table 2. Caries Status of Dentocult SM by Grade

Dentocult SM Test	Examination	Grade 0	Grade 1	Grade 2	Grade 3	Total
Number of children		59	11	9	3	82
Number of caries	Baseline	19	7	8	3	37
	Follow-up	36	8	8	3	55
Caries incidence	Baseline	33.20	63.64	88.89	100.00	45.12
	Follow-up	61.02	72.73	88.89	100.00	67.07
dft x±s	Baseline	0.75±1.32	1.91±2.17	5.11±5.30	4.67±3.51	1.52±2.68
	Follow-up	1.78±2.11	3.00±3.07	6.56±5.43	6.00±5.57	2.62±3.27
CSI x±s	Baseline	1.81±3.19	4.77±5.41	15.42±16.84	15.83±11.55	4.21±8.09
	Follow-up	4.46±5.76	7.23±7.11	22.11±25.66	18.28±15.76	7.28±11.65

Table 3 Distribution of Dentocult SM, Dentocult LB and Dentobuff Strip by Degree and Gender

Test	Gender	Number of cases	0 Degree		1 Degree		2 Degree		3 Degree	
			Number	%	Number	%	Number	%	Number	%
Dentocult SM	Male	43	26	60.47	9	20.93	6	13.95	2	4.65
	Female	39	33	84.62	2	5.13	3	7.69	1	2.56
	Total	82	59	71.95	11	13.41	9	10.98	3	3.66
Dentocult LB	Male	43	12	27.91	11	25.58	15	34.88	5	11.63
	Female	39	10	25.64	6	15.38	15	38.46	8	20.51
	Total	82	22	26.83	17	20.73	30	36.59	13	15.85
Dentobuff Strip	Male	43	4	9.30	13	30.23	26	60.47		
	Female	39	6	15.38	12	30.77	21	53.85		
	Total	82	10	12.20	25	30.49	47	57.31		

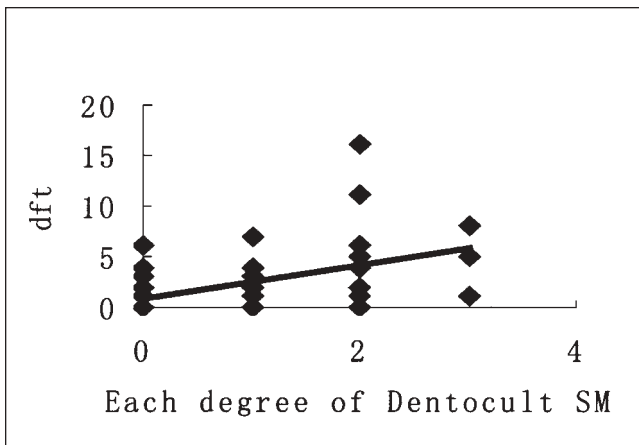


Figure 1. Distribution and trend of dft in relation to Dentocult SM degree at baseline examination

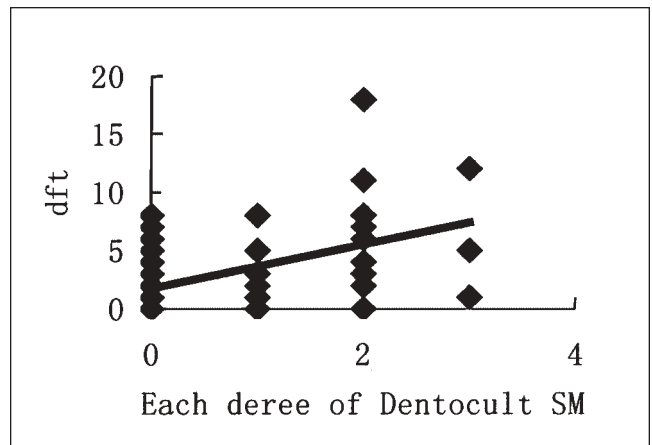


Figure 2. Distribution and trend of dft in relation to Dentocult SM degree at 2-year-later examination

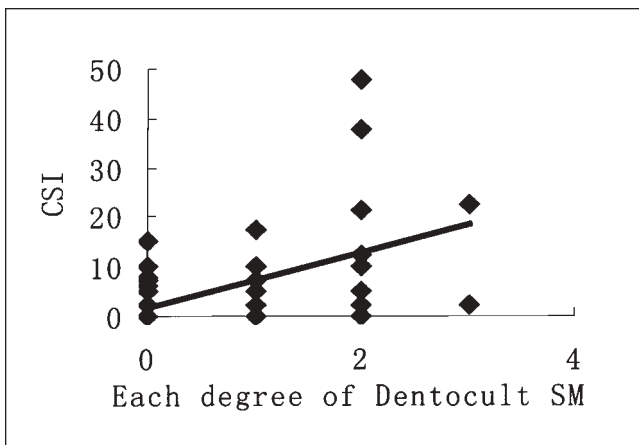


Figure 3. Distribution and trend of CSI in relation to Dentocult SM degree at baseline examination

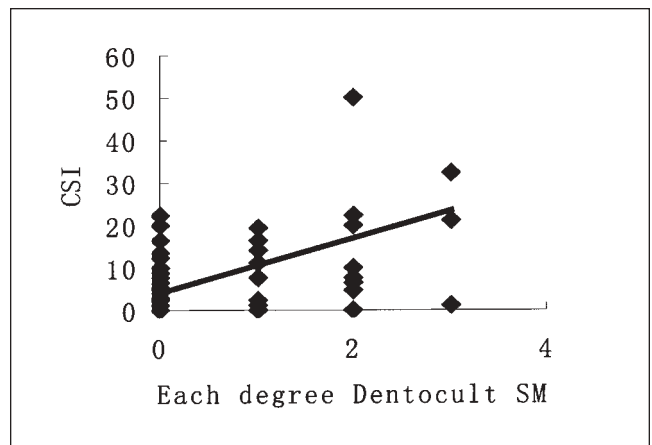


Figure 4. Distribution and trend of CSI in relation to Dentocult SM degree at 2-year-later examination

### Results of Dentocult SM detection

Caries status by grade is shown in Table 2.

Caries incidence of each grade showed significant variances in the baseline examination ( $\chi^2 = 16.11$ ,  $p < 0.05$ ). The SNK method test revealed variances between Degrees 0, 1, 2 and 3 ( $p < 0.05$ ), while no variation was observed two years later ( $\chi^2 = 4.55$ ,  $p > 0.05$ ).

There were significant variances in dft of each degree in both examinations ( $F = 11.95$ ,  $F = 8.67$ ,  $p < 0.001$ ). There were differences between Degrees 0, 1, 2 and 3 with the SNK method in the baseline examination as well as between Degrees 0, 2 and 3 two years later.

There were also considerable differences in the CSI between degrees in both examinations ( $F = 14.30$ ,  $F = 8.92$ ,  $p < 0.001$ ). The result from the SNK test showed that there were differences between Degrees 0, 1, 2 and 3 in the two examinations.

### Relationship between each degree and condition of caries

There was a clear Spearman rank correlation in both

examinations (baseline dft:  $r = 0.49$ ,  $p < 0.001$ ; second exam dft:  $r = 0.37$ ,  $p < 0.001$ ). The regression equations were  $Y = 1.72X + 0.73$ ,  $Y = 1.87X + 1.76$  respectively. Figures 1 and 2 show the regression line.

The baseline CSI:  $r = 0.49$ ,  $p < 0.001$ ; two years later:  $r = 0.35$ ,  $p < 0.001$ . The regression equations were  $Y = 5.54X + 1.64$  and  $Y = 6.48X + 4.27$  respectively. Figures 3, 4 show the regression line.

3. The distribution by degree and gender is displayed in Table 3.

The Dentocult SM distribution for each degree showed no gender differences.

### Results of Dentocult LB detection

Caries status by degree is shown in Table 4.

Each degree shows significant variances in caries incidence ( $p < 0.05$ ). The SNK results revealed clear differences between Degree 0 and Degrees 1, 2 and 3,

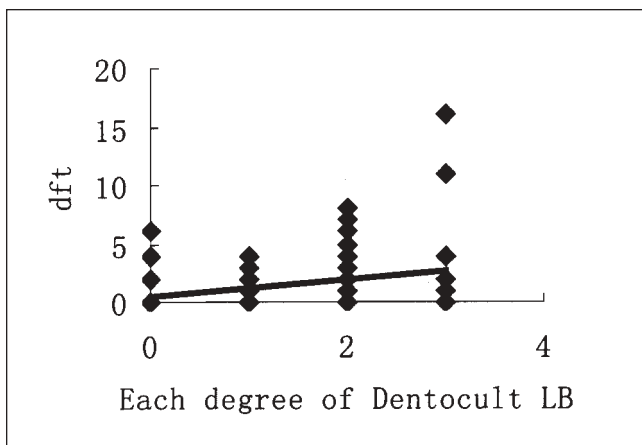


Figure 5. Distribution and trend of dft in relation to Dentocult LB degree at baseline examination

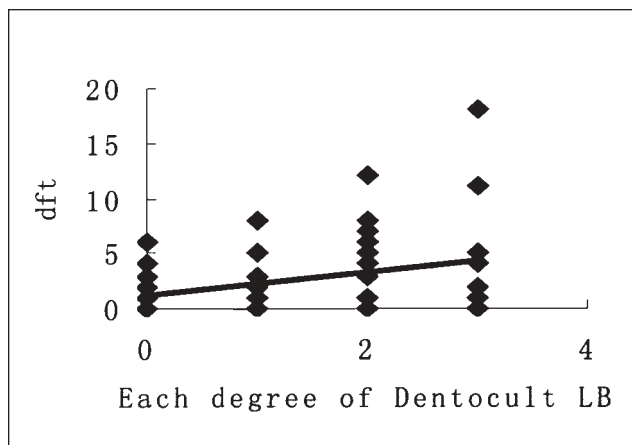


Figure 6. Distribution and trend of dft in relation to Dentocult SM degree at 2-year-later examination

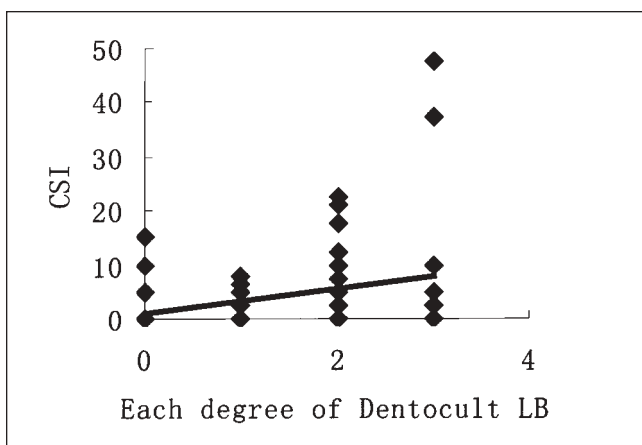


Figure 7. Distribution and trend of CSI in relation to Dentocult LB degree at baseline examination.

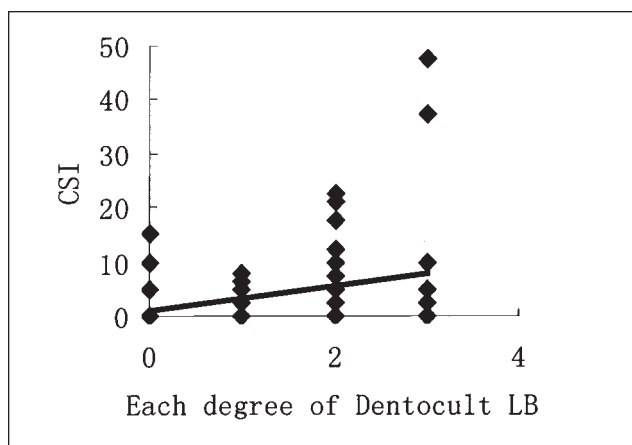


Figure 8. Distribution and trend of CSI in relation to Dentocult LB degree at 2-year-later examination.

while no variances were found in the second examination.

There was no variance in dft of each degree in the basic examination, while a significant variation was seen two years later ( $p < 0.05$ ). Substantial differences were observed between Degree 0 and Degree 3 with the SNK method. No by-degree variation in CSI was found in the basic examination, whereas there were obvious differences in the second examination. The SNK method showed differences between Degree 0, Degree 1 and Degree 3.

#### Relationship between each degree and caries status

The Spearman rank correlation results showed clear correlation between each degree and the dft index in both examinations ( $r = 0.27$ ,  $r = 0.31$ ,  $p < 0.05$ ). The regression equations were  $Y = 0.72X + 0.50$  and  $Y = 1.06X + 1.13$  respectively. Figures 5 and 6 show the regression line.

There was a high degree of correlation between each grade and the Caries Severity Index in both examinations ( $r = 0.27$ ,  $r = 0.31$ ,  $p < 0.05$ ). Regression equations were  $Y = 2.26X + 1.02$  and  $Y = 3.77X + 1.95$  respectively. Figures 7 and 8 show the regression line.

3. The Dentocult LB distribution by degree and gender is shown in Table 3. The Dentocult LB distribution showed no variations between the genders.

#### Results of Dentobuff Strip detection

Caries status by grade is displayed in Table 6.

There was no inter-grade variation in caries incidence, dft or CSI in both examinations.

#### Relationship between each Dentobuff Strip grade and caries status

None was observed between each grade and the dft and CSI indices in the baseline examination ( $r = -0.197$ ,  $r = 0.196$ ,  $p > 0.05$ ), whereas significant relation was found two years later ( $r = -0.235$ ,  $r = -0.222$ ,  $p < 0.05$ ). The regression equations were  $Y = 5.42 - 1.14X$  and  $Y = 14.15 - 2.80X$  respectively. The regression line is shown in Figures 9 and 10.

3. The Dentobuff Strip distribution by degree and gender is displayed in Table 3.

No distribution variation is shown between genders.

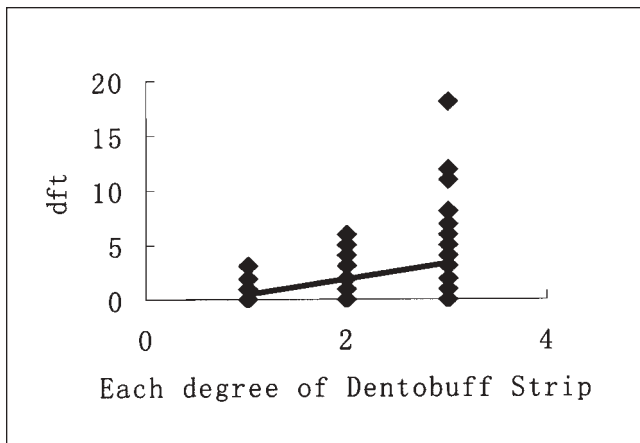


Figure 9. Distribution and dft trend relative to Dentobuff Strip degrees in follow-up examination

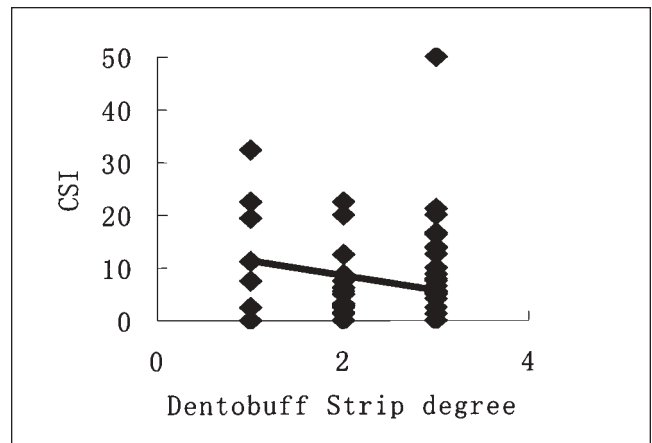


Figure 10. Distribution and CSI trend relative to Dentobuff Strip degrees in follow-up examination

## DISCUSSION

### Significance of caries activity detection in preschool-age children

There are certain distinct categories of caries in deciduous teeth; e.g., higher caries incidence, early invasion, and simultaneous and multiple invasion. Deciduous teeth caries in preschool children is still serious in China. A national survey of oral health epidemic reported that prevalence of deciduous caries among 5-year-old children was at 76.55%, and the dft index was 4.48. In terms of treatment, 55% of the children needed one tooth treated, 47% needed two teeth treated,<sup>1</sup> 15.4% required treatment for seven teeth, and 4.5% had as many as nine teeth needing treatment. The task of preventing and treating deciduous tooth caries appears to be a formidable one considering that oral health professionals, especially those practicing in pediatric dentistry and preventive dentistry, are few in numbers compared with the size of the general population. Deciduous tooth caries is detrimental to permanent teeth, the dentition, growth and development of the maxillofacial region, and to general health and the psychology of children, an issue that is attracting increasing attention. It is clear that prevention and treatment of deciduous tooth decay in young children is an arduous task and calls for special emphasis.

Individual susceptibility to caries varies. Caries activity detection can reveal the varying degree of severity of the individual and of the group being examined, and can guide us in taking appropriate preventive measures and choosing treatment strategies, thus promoting increased efficiency and saving human and material resources. It is our conclusion that, by identifying the severity and deleterious effects of deciduous decay, caries activity detection plays a primary role in strengthening therapeutic efficacy and effective prevention.

### Selection of a caries activity detection method

Hardley began to study caries activity by detecting the Lactobacillus count in saliva as early as 1933.<sup>2</sup> Many studies on caries activity are aimed at relevant micro-organism, host and food. But to date the ideal method evaluated in terms of sensitivity, specialization and reliability has not been found. Detection methods operating on the micro-organism factor mostly get saliva and bacterial plaque samples, count the number of relevant bacteria, and determine the bacterial plaque pH and acidogenic capacity by a pH electrode or chromometry. When the host factor is analyzed, samples are taken of the saliva and the enamel. On the former, its flow volume, viscosity, demineralizing and buffer capacity are tested, while the fluorine content and acido-resistance of the latter are measured.

The three detecting methods in this study use only saliva as samples, since its bacteria content reflects the bacteria count on the tooth surface. Moreover, the paraffin pellets chewed by the children separates the bacteria from the tooth surfaces and mixes them with the saliva. A special medium is selected for each of the Dentocult SM and Dentocult LB detection methods: the former detects the streptococcus mutant count, while the latter medium measures the lactobacilli. Usually, the buffer capacity is higher in stimulated saliva than in static saliva. Moreover, these three methods all test saliva samples, and it is not difficult to determine the results by comparing the color changes with the standard chart. Currently, there are few test-proven detection methods on the market. In selecting the optimal method, beside considering its reliability, ease of application and cost effectiveness should not be ignored.

### Evaluation of the three detection methods

In view of the prevalence of caries activity among preschool age children, understanding whether any method can reveal caries activity and predict its

progress will contribute much toward the work of caries prevention and treatment.

The three detection methods under study all show no apparent gender differences, which is consistent with the findings in caries incidence rate, dft, and CSI between the sexes.

Results from the two-year longitudinal observation and statistical analysis suggest that, of the three detection procedures, Dentocult SM is the best method to reveal human caries activity. The Dentocult SM results correlate to the dft and CSI values in both examinations. The dft and CSI of each group classified by degree showed significant variances between the two examinations. This suggests the ability of the method to diagnose caries condition and forecast its progress. Although Dentocult LB also correlates to the dft and CSI indices and shows differences by degree between the baseline and the follow-up exams, it is inferior in that it does not show dft and CSI differences between the degrees. Dentobuff Strip is the least

desirable method. There is no dft or CSI difference of each grade between the first and second examinations. Although there is correlation between the two examinations, it is less accentuated. On the whole, each aspect shows lower reliability.

To sum up, caries activity detection plays a vital role in preventing and treating caries in preschool age children. Results from the Dentocult SM application show that the method can detect presence of caries activity and forecast its progress, and is correlated to caries severity with high statistical significance. Dentocult LB is less desirable, and Dentobuff Strip the least. Better as the first two may be, they are still not the optimal caries activity detection systems. Further search is still necessary.

#### REFERENCES

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