

The Correlation Analysis of Caries Status Between Primary Molars and First Permanent Molars

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Research article

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Abstract

Background First Permanent Molars (PFMs) are the most critical teeth in the dental arc. Meanwhile they bear the highest risk for carious lesions. The aim of this study is to investigate the caries status of primary and permanent teeth among 8-9-year-old children in Guangzhou, and the correlation between the caries of primary molars and first permanent molars(FPMs).

Methods 119 samples of children aged 8-9 were included. The scoring and evaluation were processed in accordance with International Caries Detection and Assessment System (ICDAS). Statistical analysis was performed using SPSS 20.0 software package by means of Pearson Chi-square test and Kendall's correlation.

Results Pearson Chi-Square test showed that the prevalence of dental caries of the first primary molars, second primary molars and primary molars had significant correlation with that of FPMs while Kendall's correlation analysis showed that they had weak positive correlation. What's more, the Pearson chi-square test showed that there was no significant correlation between the degree of dental caries of different primary molars and PFM.

Conclusion Caries in primary molars, especially the second molar, are considered to be a risk indicator for the development of permanent molars in the future. However, regardless of the degree of primary molars caries, the susceptibility of FPMs caries should be aware of. And pit and fissure sealants for them should be carried out as soon as possible.

Background

First Permanent Molars (FPMs), which usually erupt between 6–7 years old, are the most critical teeth in the dental arc. Meanwhile they bear the highest risk for carious lesions. It usually results in tooth defects, pulpitis, apical periodontitis, and possibly great pain. Dental caries in childhood may also affect the growth and development of the dental maxillofacial system and children's physical and mental health. During mixed dentition stage, primary teeth will be replaced by permanent teeth. Permanent teeth will last a lifetime and have great importance to the growth and development of children.

An epidemiological survey of children's oral health in Guangzhou shows that the school age is a period of susceptibility and rapid development period of dental caries. According to the report of the Fourth National Oral Health Epidemiological Survey in China, the prevalence of permanent tooth caries among the 12-year-old group was 38.5%, while the prevalence of primary tooth caries in the 3-5-year-old group was 62.5%. Moreover, Huang [2] found that caries prevalence and DMFT of permanent teeth are even more serious in children in Guangdong.

Currently, there are several methods to identify children's risk of dental caries, including caries activity test, saliva test and other laboratory test in combination with social behavior analysis [3]. However, such complicated predictive tests are impractical and too costly for actual dental practice. Several studies [4–

6] reported that the dental caries experience of primary teeth may serve as one of the predictors of future carious lesion development of the FPMs. But there are few reports in China so far. Therefore, it is extremely valuable to find a way to predict dental caries and offer the high-risk population with more effective prevention education.

Moreover, we have noticed that there seemed to be some relationship in caries status between primary molars and first permanent molars. Thus, the null hypotheses tested are as follows: (1) There is also a significant difference in the dental caries of primary and permanent teeth among children in Guangzhou. (2) The severity of molar caries is a sharp predictor of the prevalence of FPM caries. We wish this study can provide a better understanding of how to predict dental caries.

Methods

Ethics Committee's Approval

Ethical clearance about this study was sought from Ethics Committee of Nanfang Hospital, Southern Medical University, Guangzhou, China. The protocol and objectives of the study was explained to the subjects in a simple language and informed consent were obtained from parents before the study.

Sampling

The subjects were drawn from 560 children aged between 8 and 9 years old who were in grade three in elementary school in Guangzhou, China. Children were excluded from the study if they suffered from a systemic disease or dental diseases involving dental emergency, dental trauma or tooth developmental defects, do not have parental consent or fail to cooperate. What is more, their four FPMs were supposed to be retained in mouth, and no primary molars loss was allowed. Finally, 119 children were selected, including 63 boys and 56 girls. The protocol and objectives of the study was explained to subjects in a simple language and informed consent was obtained from parents before the study.

Materials

Equipment involving portable dental unit, portable chair and portable spotlight, and instruments including dental low speed handpiece, disposable curved plate, oral mirror, CPI probe, forceps and mini-brush were used.

Examination criteria

The International Caries Detection and Assessment System(ICDAS) was adopted in our research. It contains the classification of enamel caries and different types of caries divided by severity, which is helpful for analyzing risk factors, detecting the development, and formulating treatment plans for caries [7,8]. WHO system is widely adopted in China for years, but there are certain limitations. The WHO diagnostic criteria use DMFT or DMFS to classify subjects into caries and caries-free. The severity and

development of caries seem to be ignored and as well as the description of enamel caries. Therefore, we used ICDAS in our research.

This survey adopted ICDAS to evaluate the dental caries status of the tested teeth. They were examined by dentists using the ICDAS-II graded scores 0–6[8]. ICDAS two-digit coding method was adopted, which was suggested to identify restorations/sealants with the first digit, followed by the appropriate caries code. Detailed scoring criteria are included below (Table 1).

Finally, the survey divided the ICDAS codes into three classes, D0: Score 0, health teeth; D1-3: Score 1 to 3, enamel caries; D4-6: Score 4 to 6, dentin caries. As children's primary teeth are mostly missing due to caries, the missing primary teeth score is 6.

Pre-examination training

A total of 3 dentists who received a calibration training in accordance with the ICDAS Coordinating Committee Manual (<http://www.icdas.org>) evaluated dental caries. They were familiar with the operating procedures and the use of device. Ten subjects were randomly chosen for oral examination of primary molars and FPMs, and the results were recorded. According to the statistics software Minitab, there is good agreement between examiners among examiners ($\kappa = 0.82$).

The recorder should be familiar with the investigation process and master the checklist items and recording methods before conducting the investigation.

Dental examination

Firstly, plaque layers were removed from the tooth surfaces of primary molars and FPMs with mini-brushes. Then the occlusal, buccal, lingual and proximal surfaces of the FPMs were examined to detect the ICDAS score. Similarly, the primary molars were examined and recorded according to ICDAS-II. Detailed examination steps and codes are included below (Chart 1).

Data analysis

Data analyses was performed using SPSS 20.0. The Pearson Chi-Square test was used to describe the correlation between the prevalence of FPMs caries and primary molar caries. In addition, Kendall's rank correlation coefficient was analyzed. The area under the ROC curve could be considered as a method to evaluate the diagnostic value of predicting FPM caries by assessing the dental caries status of primary molar. The significance level was $\alpha = 0.05$, and $P < 0.05$ was considered statistically significant.

Result

Caries prevalence

Overall caries prevalence in FPMs and primary molars of children in Guangzhou

The total caries prevalence rate in primary molars of 119 children in Guangzhou was 90.8%, of which dentin caries rate was 73.9%. The caries prevalence in FPMs was 82.4%, of which dentin caries was 15.1%. The caries prevalence in first and second primary molars were 73.9% and 89.1%, respectively, of which dentin caries were 66.4% and 60.5%. Moreover, there was no statistically significant difference between male and female in caries prevalence or dentin caries prevalence. Detailed statistical information are shown below (Table 2).

Caries status of FPMs and primary molars

Of the 476 first permanent molars of 119 children, the prevalence of dental caries rate was 53.4%. Among them, enamel caries accounted for 48.6%, while dentin caries accounted for only 4.8%. We use the ICDAS system which was described above to score caries. It turns out that the ICDAS score of the carious FPMs is concentrated on D1 and D2, accounting for 82.01% of the total caries. The detailed statistical information are included below (Table 3).

According to examination, 93 of the 476 FPMs were treated with pit and fissure sealant, and the rate of sealant was 19.54%. Among these 93 teeth, 21 were sealed partially and 72 were completely sealed. For caries prevalence, teeth treated with pit and crack sealants are lower than teeth treated without sealants. In addition, completely closed teeth have a lower caries rate than partially closed teeth. Detailed statistical information are shown below (Table 4).

Correlation analysis between caries status of primary and permanent teeth

The correlation between primary molars and the first permanent molars is displayed in Table 5. Pearson chi-square test showed that the caries prevalence of dental caries in the second primary molar or primary molar was significantly correlated with the prevalence of FPMs dental caries ($P < 0.05$). It suggests that the prevalence of caries in FPMs is related to the caries status of the first primary molars, second primary molars and primary molars. Kendall's rank correlation analysis showed that the positive correlation between them was weak ($\tau_b = 0.095, 0.147, 0.119, P < 0.05$). Among them, the correlation coefficient between FPM and the second molar is the highest.

As caries predictor of FPMs, the caries status of the first primary molars, second primary molars and primary molar is statistically significant. Furthermore, the caries status of first primary molar, second primary molar and primary molar caries respectively resulted in a value of 0.578, 0.602 and 0.592 under the ROC curve, as shown in Figure 1.

Correlation between caries severity of primary molars and caries prevalence of FPMs

According to the severity of caries, the carious primary molars were mainly divided into enamel caries group and dentin caries group, and the correlation between the caries severity and the prevalence of FPMs was analyzed. As shown in Table 6, the Pearson chi-square test showed that there was no statistical significance between the prevalence of caries in FPM and the severity of caries in the first

primary molars, second primary molars or primary molars ($P > 0.05$). It fails to say that the caries severity of primary molars is associated with the dental caries prevalence of FPMs.

Discussion

Although some researches [4–6] have already been conducted to determine the impact of caries in primary teeth on caries in permanent teeth, there seemed to hold some correlations. However, there is few similar reports in China so far. In our research, the caries status of primary molars and FPMs of 119 children aged 8 to 9 in Guangzhou were analyzed to study the correlation between caries status of primary molars and the prevalence of FPMs caries. We found that the prevalence of first molars and FPMs caries in children aged 8 to 9 years in Guangzhou is high and serious. The caries prevalence of FPMs, first primary molars, second primary molars and primary molars, was 82.4%, 73.9%, 89.1%, 90.8% respectively. And the prevalence of related dentin caries was 15.1%, 66.4%, 60.5% and 73.9%, respectively. These two data are much higher than Huang's 2008 results on the caries prevalence among 9-year-old children in Guangzhou (The prevalence of dental caries is 58.33% in primary teeth, and 12.08% in permanent teeth. While dentin caries prevalence of FPMs and second primary molars was close)[9]. The great differences may due to the diagnostic criteria adopted. In our study, ICDAS was used instead of the traditional WHO diagnostic criteria, in which enamel caries was considered non-caries, so the diagnosis of early caries was ignored. The new ICDAS diagnostic criteria not only combine the advantages of traditional WHO diagnostic criteria, but they are especially helpful for the detection of early dental caries [10]. Early detection of dental caries belongs to secondary prevention and is of great significance for protecting teeth. This is one of the reasons why we used ICDAS.

The caries severity of FPMs and primary molars of 119 children were further analyzed. We found that dentin caries accounted for only 4.8% of the total caries. In addition, enamel caries without formation of caries cavity accounted for 82.01%. Therefore, it can be seen that the dental caries in FPMs are mainly composed of enamel caries, most of which are white spot lesions, and no dental caries cavity is formed (ICDAS D1 and D2). This outcome may be due to the fact that they are only 8–9 years old, and the FPMs have just erupted, so the caries severity is limited. White spot lesions belonging to reversible early caries are only demineralization of tooth surfaces without formation of caries cavity, which can be restored through remineralization therapy. However, without effective interventions, the disease can progress. This is one of the advantages of the ICDAS criteria over the traditional WHO criteria, which allows a better assessment of the development of caries and provides the evidence for the treatment. Our study also found that although the prevalence of dental caries in the first primary molars is lower than that of the second primary molars, and the majority of dental caries are dentine caries, however, the second primary molars had close enamel and dentin caries prevalence. This indicates that the first primary molars have a more severe caries state than the second molar. That's why the ICDAS system is superior in detection of incipient caries and have special value in preventing dental caries in young children.

For the prevention of dental caries, early diagnosis and treatment are of great importance. Due to the high prevalence of dental caries, secondary prevention of dental caries is necessary. However, it is more

meaningful to achieve primary prevention of dental caries, which can provide effective preventive measures for susceptible populations. There are several techniques to predict dental caries, including laboratory predictions (mainly dental caries activity tests), predisposing factor prediction and so on. However, the laboratory predicts is too complicated and expensive and costly in the clinical operation to realize besides chair. Our study found that the caries prevalence of primary molars (especially second primary molars) and FPMs had weak positive correlation to certain degree and hope to provide a more practicable way to prevent dental caries.

As a caries predictor for FPMs, the caries status of the first primary molars, the second primary molars and primary molars had statistical significance. The areas under the ROC plots (AUC) is widely recognized as an accuracy index for the authentic assessment of the diagnostic test. AUC value ranges from 0.5 to 1.0, with value of 0.5–0.7 is usually interpreted as indicating “low” test accuracy, 0.7–0.9 is “moderate” accuracy, and ≥ 0.9 is “high” accuracy (Henderson,1993)[12]. In our research, the caries status of the first primary molars, second primary molars and primary molar respectively resulted in a value of 0.578, 0.602 and 0.592 under the ROC curve, indicating there is a weak prediction value. Although it is lower than that of other scholars [13], it still has certain research value. In our study, the AUC value of the second primary molars is the highest, it suggests that caries experience of second primary molars is more meaningful for predicting the caries of FPMs. In addition, our study further considered correlation between the caries severity of primary molars and the prevalence of FPMs caries, however, it turns out there is no link between them. Therefore, it may suggest that once the primary molars suffer from caries regardless of the severity of it, FPMs is at risk for caries.

As is known to all, dental caries is a multifactorial disease, and its occurrence and progress are related to the complex interaction of cultural, social, behavioral, nutritional and biological risk factors [15]. Nevertheless, regardless of whether primary teeth are mild or severely decayed, the risk of FPMs dental caries should not be ignored. To some extent, for the prevention of dental caries, the diagnosis of caries in early primary molars is as important as in FPMs.

The dental caries experience of primary molars, especially those of the secondary primary molars, can be used to predict the caries risk for FPMs, so as to early detect the susceptible population who may have FPMs caries. Effective preventive measures, such as like pit and fissure sealant, can protect susceptible populations from dental caries. According to a recent teeth protecting guideline, it is highly recommended to consider the use of fissure sealants in permanent molars for children and adolescents [15]. Considering the low fluoride content in drinking tap water in Guangzhou (0.2–0.3 mg / L) [16], preventive care for children is important.

According to our research, caries still exists in teeth treated with pit and fissure sealant, and if the sealant were not complete, the prevalence may be as high as 47.6%. Nevertheless, scholars have found the susceptibility to caries could be reduced even if partial sealant materials had missed [17]. To ensure the effect of pit and fissure sealant, attention must be paid to the selection of indications, saliva management and periodic inspection throughout the process [18].

Conclusion

As far as our research results are concerned, The prevalence of caries rate of primary molars, especially the second primary molars, has positive correlation with that of FPM caries. As a predictor of dental caries, the degree of dental caries of primary molars does not have a significant correlation with the dental caries status of FPMs. However, regardless of the degree of primary molars present, the possibility of FPMs caries should be recognized. And pit and fissure sealants for them should be carried out as soon as possible.

Abbreviations

FPMs:First Permanent Molars; ICDAS: International Caries Detection and Assessment System (dentistry); DMFT: Decayed (D), Missing (M), Filled (F) Tooth; DMFS: Decayed (D), Missing (M), Filled (F) Surface; CPI:Community Periodontal Index; WHO:World Health Organization; SPSS: Statistical Software for Social Sciences; ROC:Receiver Operator Characteristic; AUC:the Areas Under the Curve.

Declarations

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Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Author's contributions

Study design is carried out by WX. Study conduct, data collections and data analysis are performed by LX, YL, LC, XL, HL, YZ. Drafting manuscript is carried out by YL. Revising manuscript content is provided by LX. Approving final version of manuscript is done by WX. All authors read and approved the final version of the manuscript; All authors agreed to be responsible for all aspects of the study including the accuracy of the work done.

Ethics approval and consent to participate

Ethical clearance about this study was sought from Ethics Committee of Nanfang Hospital, Southern Medical University, Guangzhou, China. The protocol and objectives of the study was explained to the subjects in a simple language and informed consent were obtained from parents before the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. Parameters and Scores Used for Evaluation

Parameters	Scores	Description
The ICDAS II codes and criteria	0	Sound.
	1	First visual change in enamel.
	2	Distinct visual change in enamel.
	3	Localized enamel breakdown.
	4	Underlying dark shadow.
	5	Distinct cavity with visible dentin.
	6	Extensive distinct cavity with visible dentin.
Restoration and Sealant Codes	0	Not sealed or restored.
	1	Sealant, partial.
	2	Sealant, full.
	3	Tooth colored restoration.
	4	Amalgam restoration.
	5	Stainless steel crown.
	6	Porcelain, gold, FPM crown or veneer.
	7	Lost or broken restoration.
	8	Temporary restoration.
Scores for teeth loss	97	Tooth missing because of caries.
	98	Tooth missing for reasons other than caries.
	99	Not erupted.

Table 2. Prevalence caries rate of FPMs and primary molars and dentin caries among children aged 8 to 9 years old in Guangzhou

	First permanent molars		First primary molars		Second primary molars		Total primary molars	
	Caries	Dentin caries	Caries	Dentin caries	Caries	Dentin caries	Caries	Dentin caries
Male	81.0%	11.1%	71.4%	65.1%	88.9%	63.5%	90.5%	76.2%
Female	83.9%	19.6%	76.8%	67.9%	89.3%	57.1%	91.1%	71.4%
Total	82.4%	15.1%	73.9%	66.4%	89.1%	60.5%	90.8%	73.9%

Table 3. The type and prevalence rate of 476 FPM caries and primary molar caries

	First permanent molars		First primary molars		Second primary molars	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
0	222	46.6	243	51.1	160	33.6
D1-3	231	48.6	44	9.2	157	33
D4-6	23	4.8	189	39.7	159	33.4
Total	476	100	476	100	476	100

Table 4. Restoration and sealant rate of FPMs

	Restoration	Sealant (partial)	Sealant (complete)	Untreated
	Number (%)	Number (%)	Number (%)	Number (%)
Non-caries	4 (80.0%)	11 (52.4%)	44 (61.1%)	163 (43.1%)
Caries	1 (20.0%)	10 (47.6%)	28 (38.9%)	215 (56.9%)
Total	5 (100.0%)	21 (100.0%)	72 (100.0%)	378 (100.0%)

Table 5. The correlation between different caries of primary molars and first permanent molars

		First primary molars		Second primary molars		Total Primary molars	
		Non-caries	Caries	Non-caries	Caries	Non-caries	Caries
First permanent molars	Non-caries	132	90	97	125	81	141
	Caries	111	143	63	191	48	206
Pearson χ^2	χ^2	11.773		18.944		18.550	
	<i>P</i>	0.001		0.000		0.000	
Kendall's coefficient	τ_b	0.095		0.147		0.119	
	<i>P</i>	0.016		.000		0.002	
ROC analysis	AUC	0.578		0.602		0.592	
	<i>P</i>	0.003		0.000		0.001	

Table 6. The correlation between caries degree of primary molar and first permanent molar

		First primary molars		Second primary molars		Primary molars	
		D1-3	D4-6	D1-3	D4-6	D1-3	D4-6
First permanent molars	Non-caries	15	75	62	63	45	96
	Caries	29	114	95	96	67	139
Pearson χ^2	χ^2	0.471		0.001		0.014	
	<i>P</i>	0.493		0.981		0.905	

Figures

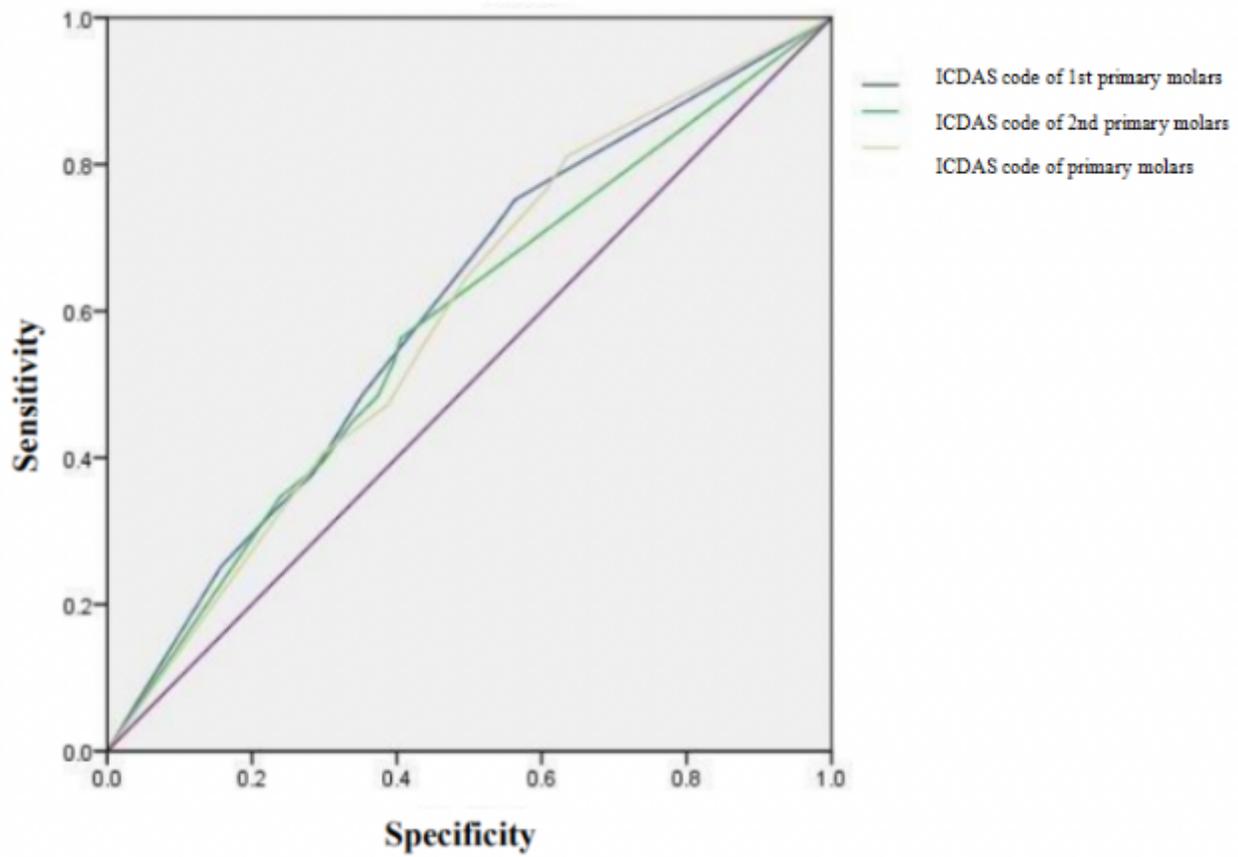


Figure 1

ROC of caries in first primary molars, second primary molars and primary molars

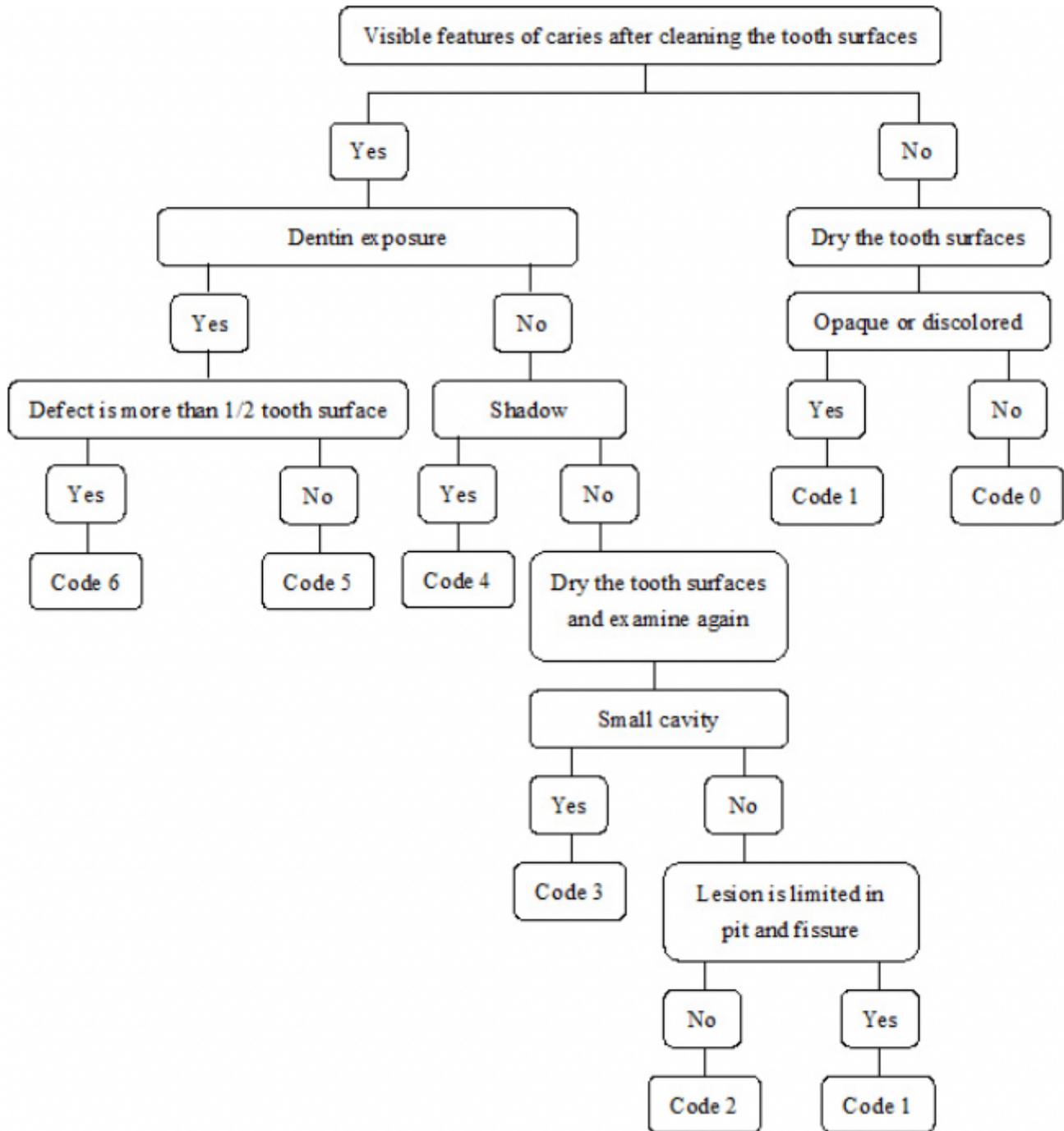


Figure 2

Chart 1. Examination flow chart of ICDAS-2