

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 (FPMs) are the most critical teeth in the dental arc. Meanwhile they bear the highest risk for carious lesions. The aim of this study was 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 FPMs.

Conclusion: Caries in primary molars, especially the second molars, were 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, even 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 are supposed to last for a lifetime and have great importance to the growth and development of children.

Epidemiological surveys of children's oral health in Guangzhou had showed that the school age was 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[1], 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] has found that caries prevalence and DMFT of permanent teeth are even more serious in children of Guangdong.

Currently, there are several methods to identify children's risk of dental caries, including caries activity test, saliva test and other laboratory tests in combination with social behavior analysis[3]. However, such complicated predictive tests are impractical and costly for actual dental practice. Several studies[4-6]

have 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 seem to be some relationship between the caries status of primary molars and first permanent molars. Thus, the null hypotheses tested are as follows: (1) There is also a significant correlation between the caries status 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 hope this study can provide a local epidemiological survey and a better understanding of how to predict dental caries.

Materials And Methods

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, not having 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(unless their missing were due to caries). 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 contained the classification of enamel caries and different types of caries divided by severity, which would be helpful for analyzing risk factors, detecting the development, and formulating treatment plans for caries [7,8]. WHO system was widely adopted in China for years, but there were certain limitations. The WHO diagnostic criteria used DMFT or DMFS to classify subjects into caries and caries-free. The severity and development of caries, as well as the description of enamel caries, could be ignored. Therefore, ICDAS was used 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 were included below (Table 1).

Finally, the ICDAS codes were divided into three classes (D0: Scored 0, health teeth; D1-3: Scored 1 to 3, enamel caries; D4-6: Scored 4 to 6, dentin caries). And the missing primary teeth due to caries were scored 6.

Pre-examination training

Dental caries were evaluated by a total of 3 dentists who had received a calibration training in accordance with the ICDAS Coordinating Committee Manual (<http://www.icdas.org>). 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, agreement among the examiners was good. ($\kappa = 0.82$).

The recorder should be familiar with the investigation process, the checklist items and the 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 scores. Similarly, the primary molars were examined and recorded too. Detailed examination steps and codes were included below (Chart 1).

Data analysis

Data analysis was performed using SPSS 20.0. The Pearson Chi-Square test was used to describe the correlation between the caries prevalence of FPMs and primary molars. 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 molars. 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 rate in first and second primary molars were 73.9% and 89.1% respectively, of which dentin caries were 66.4% and 60.5% respectively. Moreover, there was no statistically significant

difference between male and female in caries prevalence or dentin caries prevalence. Detailed statistical information were shown below (Table 2).

Caries status of FPMs and primary molars

Of the 476 first permanent molars of 119 children, the prevalence rate of dental caries was 53.4%. Among them, enamel caries accounted for 48.6%, while dentin caries accounted for only 4.8%. ICDAS system which was described above was adopted to score caries. It turned out that the records of the carious FPMs were concentrated on D1 and D2, accounting for 82.01% of the total caries. The detailed statistical information were shown 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 fissure sealant were lower than those without sealant. In addition, completely sealed teeth had a lower caries rate than partially sealed teeth. Detailed statistical information were shown below (Table 4).

Correlation analysis between caries status of primary and permanent teeth

The correlation between primary molars and the first permanent molars was displayed in Table 5. Pearson chi-square test showed that the prevalence of dental caries in the second primary molars or primary molars were significantly correlated with the prevalence of FPM caries ($P < 0.05$). It suggested that the caries prevalence in FPMs was 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 FPMs and the second molars was the highest.

As the caries predictor of FPMs, the caries status of first primary molars, second primary molars and primary molar were statistically significant. Furthermore, the caries status of first primary molars, second primary molars and primary molars 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 FPMs and the severity of caries in the first primary molars, second primary molars or primary molars ($P > 0.05$). It failed to say that the caries severities of primary molars were 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. And there seemed to exist 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 primary molars and FPMs caries in children aged 8 to 9 years in Guangzhou were high and serious. The caries prevalence of FPMs, first primary molars, second primary molars and primary molars were 82.4%, 73.9%, 89.1%, and 90.8% respectively. And the prevalence of related dentin caries were 15.1%, 66.4%, 60.5% and 73.9% respectively. These data was much higher than Huang's results on the caries prevalence among 9-year-old children in Guangzhou in 2008 (The prevalence of dental caries was 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. Enamel caries were considered non-caries in the traditional WHO diagnostic criteria so that the diagnoses of early caries were ignored. The new ICDAS diagnostic criteria—containing the advantages of traditional WHO diagnostic criteria, was helpful to detect the early dental caries [10]. Early detection of dental caries was of great significance for protecting teeth, which belonged to secondary prevention. This is one of the reasons why ICDAS was adopted.

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 could be seen that the dental caries in FPMs were mainly composed of enamel caries, most of which were white spot lesions, and no dental caries cavity was formed (ICDAS D1 and D2). This outcome might be due to the fact that they were only 8-9 years old, and the FPMs had just erupted, so the caries severity was limited. White spot lesions belonging to reversible early caries are only demineralization of tooth surfaces without formation of caries cavity, so they can be restored through remineralization therapy. However, the disease can progress without effective interventions. 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 was lower than that of the second primary molars, and the majority of dental caries were dentine caries too. However, the second primary molars had the similar enamel and dentin caries prevalence. This indicated that the first primary molars had a more severe caries state than the second molars. And that might be why the ICDAS system could be 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, expensive or 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 positive correlation to certain degree, so as 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 molars respectively resulted in a value of 0.578, 0.602 and 0.592 under the ROC curve, indicating there was weak prediction value. Although it was lower than that of other scholars [13], it still had certain research value. In our study, the AUC value of the second primary molars was the highest which suggested that caries experience of second primary molars was 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 turned out there was no link between them. Therefore, regardless of their severities, it might suggest that once the primary molars suffer from caries, FPMs was at risk for caries.

As is known to all, dental caries is a multifactorial disease. Its occurrence and progress are related to the complex interaction of cultural, social, behavioral, nutritional and biological risk factors [15]. Nevertheless, regardless of mild or severe decayed situation in the primary teeth, 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. Effective preventive measures, such as 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 were still detected in the teeth treated with pit and fissure sealant. The prevalence could be as high as 47.6% if their sealants were not complete. 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 were concerned, prevalence of caries rate of primary molars, especially the second primary molars, had positive correlation with that of FPMs. As a predictor of dental caries, the degrees of dental caries of primary molars did not have a significant correlation with the dental caries

status of FPMs. However, regardless of the caries degree of primary molars present, the possibility of FPMs caries should be recognized. And pit and fissure sealant for them should be carried out as soon as possible.

Declarations

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.

Availability of data and material

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Study design is carried out by Wenan Xu. Study conduct is performed by Liang Xu, Yuee Liang, Leyi Chen, Xiaolin Lv, Haixia Liu, Youran Zhao. Data collection is done by Liang Xu, Yuee Liang, Leyi Chen, Xiaolin Lv, Haixia Liu, Youran Zhao. Data analysis is carried out by Liang Xu, Yuee Liang, Leyi Chen, Xiaolin Lv, Haixia Liu, Youran Zhao. Drafting manuscript is carried out by Yuee Liang. Revising manuscript content is provided by Liang Xu. Approving final version of manuscript is done by Wenan Xu.

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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: Areas Under the Curve.

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Tables

Due to technological limitations, Table 1 is only available as a download in the supplementary files section.

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	
	P	0.001		0.000		0.000	
Kendall's coefficient	τ_b	0.095		0.147		0.119	
	P	0.016		.000		0.002	
ROC analysis	AUC	0.578		0.602		0.592	
	P	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	
	P	0.493		0.981		0.905	

Figures

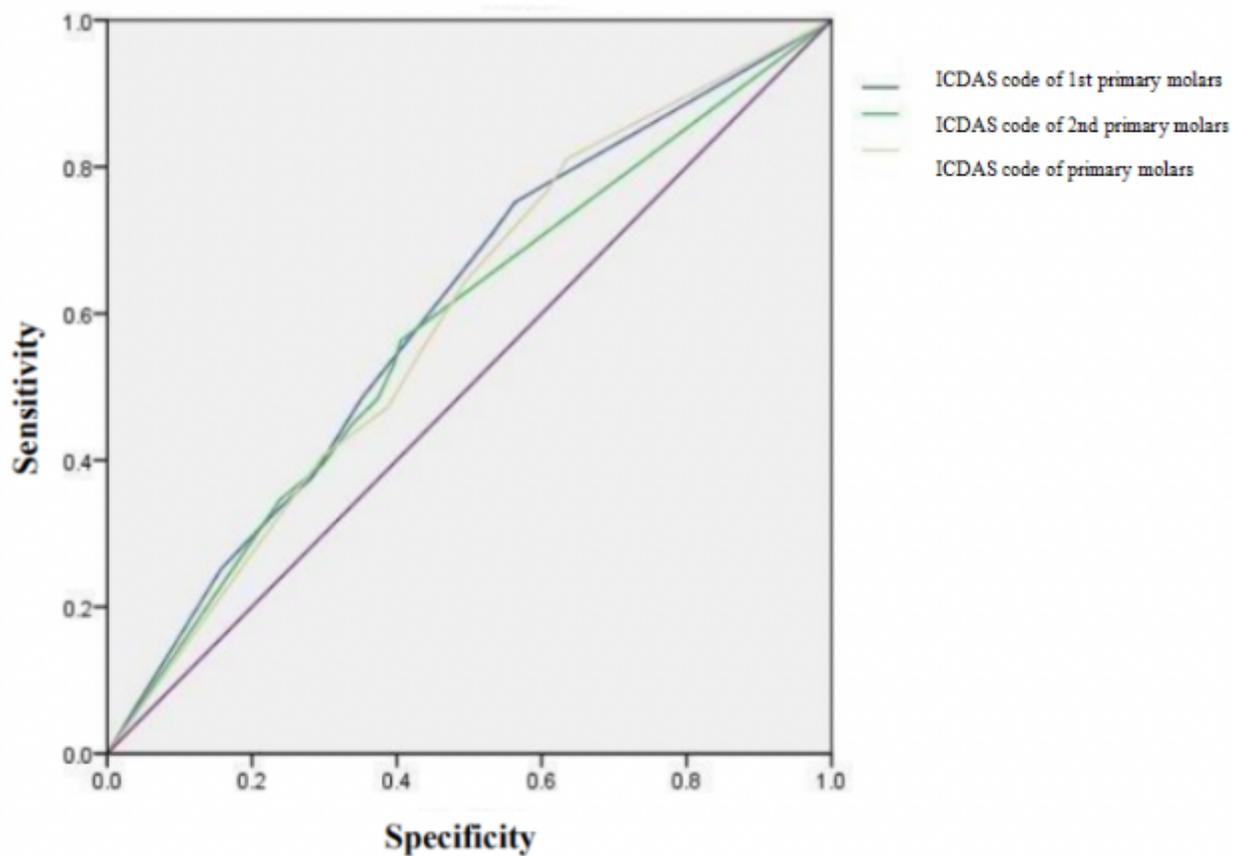


Figure 1

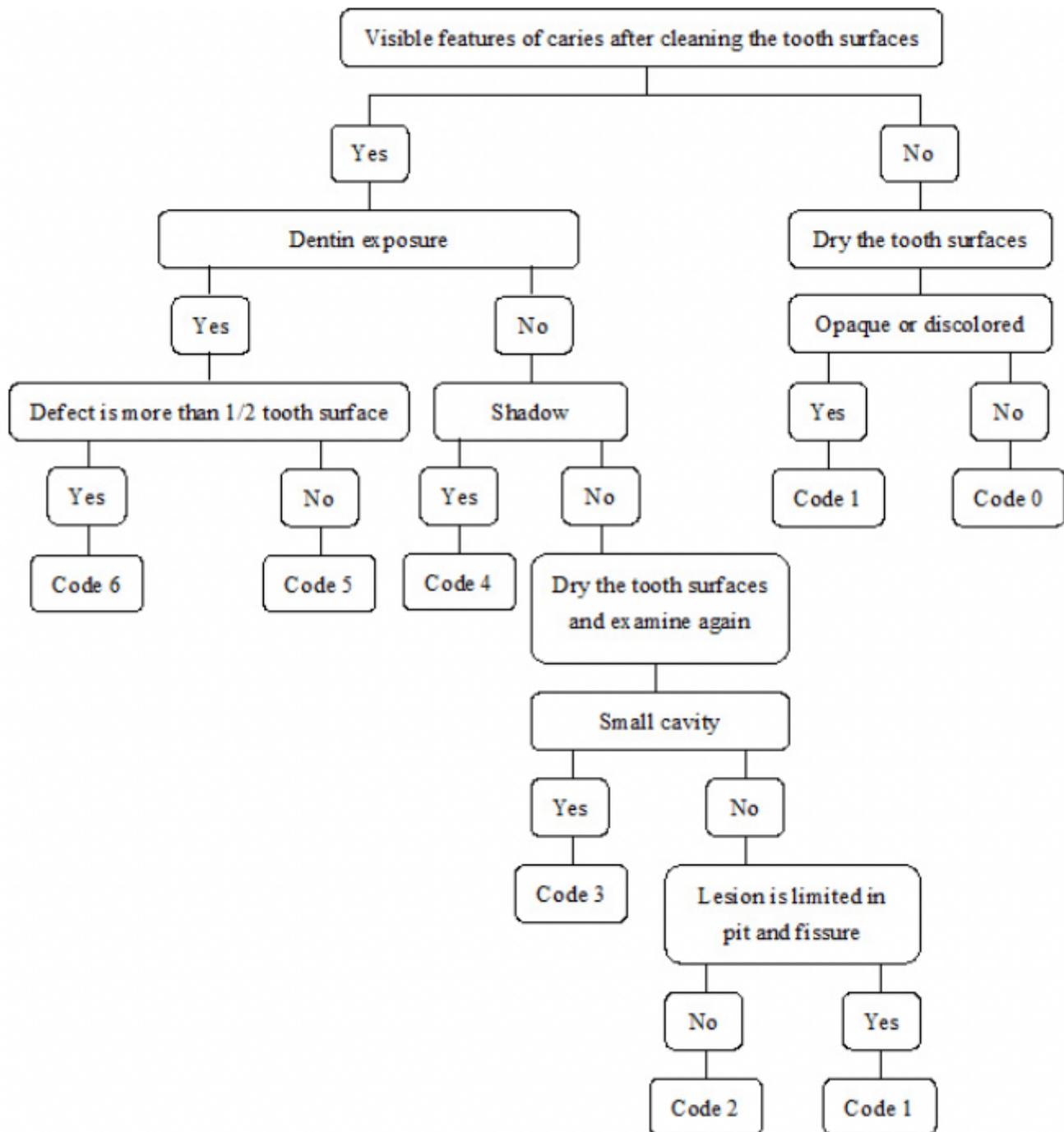


Figure 2

Chart 1. Examination flow chart of ICDAS- α

Supplementary Files

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