

**Caries assessment by clinical examination with or without radiograph of young Chinese adults**

**C H CHU, B T O CHUNG, E C M LO**

Hong Kong SAR, China

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**Correspondence to :** Dr C H Chu

Faculty of Dentistry

The University of Hong Kong

34 Hospital Road

Hong Kong, China

Email: [chchu@hku.hk](mailto:chchu@hku.hk)

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## **Abstract**

**Objective:** *The aim of this study was to compare caries status assessment of posterior teeth of young Chinese adults between using clinical examination alone and with supplement of bitewing radiographs.*

**Methods:** *Two calibrated dentists examined posterior teeth of 200 Chinese university students (aged 18-24 years) using dental mirrors and probes under optimal lighting. Caries was diagnosed by visual detection of carious cavity. Duplicate examinations were performed to monitor intra- and inter-examiner variations. Bitewing radiographs were taken and examined by an independent dentist. Caries was recorded when a lesion extended into dentin.*

**Results:** *Among the 3,162 posterior teeth examined, 113 caries were found. More than one third (35.4%) of the caries found in the posterior teeth were not detected from reading the radiographs but were detected in the clinical examinations. About half (51.4%) of the caries were found on the bitewing radiographs only, leaving 13.2% of the caries being detected by using either method. With the supplement of bitewing radiographs, there was a 105% increase in the number of caries detected. This leads to a correction factor of 1.13 for adjustment of the mean DMFT score obtained from conducting clinical examinations alone.*

**Conclusion:** *Due to the significant number of clinically undetected dental caries in these young Chinese adults who live in a community with water fluoridation, it may be advisable to use a correction factor to adjust the caries experience obtained from epidemiological surveys when bitewing radiographs are not available.*

# **Caries assessment by clinical examination with or without radiograph of young Chinese adults**

## **Introduction**

An accurate and precise assessment of caries status is essential to both dental practice and epidemiological research. Clinical examination is basically a visual evaluation. It is often inadequate when used solely for caries assessment. With the widely and increasingly use of fluoride in dentistry, more and more caries have been found 'hiding' under the intact enamel surface. Several studies have shown that the prevalence of dental caries is significantly underestimated when clinical data are compared with radiographic information (Hintze and Wenzel 1994; Richardson and McIntyre 1996; Poorterman et al. 1999; Poorterman et al. 2000a). A review study reported that the use of bitewing radiographs, as an aid to clinical diagnosis, is essential if much dental caries is not to be missed (Kidd and Pitts, 1990). However, the results show a large range in the number of additional carious lesions diagnosed by the radiographic examination. This might be related to the different age groups used and the caries prevalence of the population under study.

Dental caries beneath the restorations may not be found in visual examination. Bitewing radiographs can reveal additional significant information such as the hidden or fluoride caries and the quality of dental restorations (Kroeze et al., 1990). The use of Bitewing radiographs in caries assessment affects the outcome of routine epidemiological research in which no additional diagnostic aids like bitewing radiographs are used. In those reports, reference is usually made to the possible undervaluation of the presence of dental caries (Hintze and Wenzel 1994; Richardson and McIntyre 1996; Poorterman et al. 1999; Poorterman et al. 2000a), but to what extent this phenomenon interfered with the results found is reported to be unknown or assumed to be small. This numerical uncertainty about the epidemiological outcome data lacks a solid base for evidence-based improvements in oral health and oral health care in the future. Thus, it is necessary to find out the magnitude of the underestimation of caries in standard epidemiological studies. Furthermore, there is no report published in English to study the use of Bitewing radiograph in the assessment of caries status in the Chinese population. The aim of present study is to compare the assessment of caries status in young Chinese adults between using clinical examination alone and with supplement of bitewing radiographs.

## **Materials and Methods**

A university in Hong Kong provides free dental examination for all first year university students. Among the students attending the free dental examination, 200 Chinese students were randomly selected for this study of caries assessment. The research protocol was approved by the University Health Service Board and consent was sought from all participants. Two calibrated dentists conducted a standardised dental examination in the university campus. Portable dental chairs were used as in field survey setting. The caries diagnostic criteria used clinically were adapted from the World Health Organisation (WHO) in 1997. Clinical examination of the posterior teeth was carried out using an intra-oral fibre-optic light, front surface dental mirror and a sickle probe. The diagnosis was made by visual detection of carious cavities. Visual evaluation was preferred in the examination to avoid the potential damage to teeth with the use of the probe as a diagnostic aid. Only in cases of doubt the probe was used very carefully to remove plaque and debris for definite visual examination. Around 10% of participants were re-examined for assessment of the intra- and inter-examiner agreement in caries assessment.

Left and right Bitewing radiographs using Kodak Ultra-Speed Intraoral Dental Film (Carestream Health, Inc. New York, USA) were taken by a standard technique with film holder (Rinn's XCP, Dentsply, Illinois, USA). Trophy intra-oral X-ray machine (EXT, Trophy Radiology S.A., Paris, France) was used with an exposure time of 0.3s. The films were developed using an automated developer (Periomat, Dürr Dental GmbH & Co. Bietigheim-Bissingen, Germany). An independent experienced dentist who did not participate in the clinical survey judged the sample bitewing radiographs using a radiograph viewing box and a magnifier (x4). The distal surface of the first premolar to the distal surface of the second molar was examined. Caries was recorded when radiolucency visible in the enamel definitely passing the amelo-dentinal junction into dentin. No caries was recorded when there was a doubt. Those cases where no judgement could be made included teeth with crowns, crowded teeth and missing teeth.

The intra-examiner reliability of the radiographic examination of proximal and occlusal surfaces of the posterior teeth was assessed by re-examination of 10% randomly selected bitewing radiograph. The inter- and intra-examiner agreements of the clinical and radiographic

examinations were determined using Cohen's Kappa (Cohen, 1960). Previous epidemiological survey reported the dental caries of Chinese young adults was about  $0.3 \pm 0.1$  (Lo and Chu, 1994) and we estimated there would be 10% more caries detected with radiographic examination. With the level of significance set at 5% and the power chosen at 80%, the minimal number of participants required was 175. We predicted about 10% students would decline to join the study. Therefore 200 Chinese students were recruited in this research. The comparison of the clinical and radiographic data (sound vs. caries) was performed and the relative diagnostic yields of the clinical and radiographic examinations were assessed. Chi-square test was used to assess the statistical significance of the differences in the distribution of clinically detected carious lesions with those detected radiographically.

## Results

A total of 736 Chinese students attended the free dental examination. Among them 200 students were randomly selected and they all joined this study. They aged from 18 to 24 and their mean age was  $21.1 \pm 1.4$ . Their caries experience in mean DMFT score assessed by clinical examination was  $2.31 \pm 2.77$ . A total of 3,162 posterior teeth were examined and 113 teeth with caries advancing into dentin were found when combining the results of the clinical and the radiographic examination (Table 1). The intra- and inter-examiner agreements in clinical examination and the intra-examiner agreement in radiographic assessment were all over 90%.

About one third (35.4%) of the carious caries were detected clinically but not radiographically. One half of carious lesions (51.4%) were found on the bitewing radiographs only, leaving 13.2% of the lesions detected by both methods. In the clinical examination 55 (48.7%) of the 113 carious teeth were detected. The extra diagnostic yield of the bitewing radiographs, calculated as the number of carious teeth additionally detected divided by the number of carious teeth found clinically, was 105%.

The numbers of teeth with carious caries clinically detected and radiographically detected are reported in Table 2. Among the 3,162 teeth examined, 40 carious teeth that were not discovered radiographically were detected in the clinical examination. A total of 58 carious teeth with carious lesions were found on the bitewing radiographs only but not in the clinical examination. Finally, 15 carious teeth were detected in both examinations. The percentage of teeth with caries detected by clinical examination was 1.7% and the percentage of teeth with

caries detected by bitewing examination was 2.3%. The total percentage of teeth with carious caries detected in this study by combining the clinical and radiographic examinations was 3.6%. Chi-square test revealed a statistically significant difference between the numbers of radiographically detected and clinically detected carious lesions ( $p < 0.001$ ).

The clinically based caries status (DT scores) and caries experience (DMFT scores) are shown in Table 3. Based on clinical judgement alone, DT was 0.28; but it increased to 0.57 when the radiographic examination was included. It can be seen that there was a 105% increase in the number of decayed teeth detected when radiographs were also examined. This resulted in an increase (13%) of caries experience (DMFT). The adjusted DMFT score of the survey population would be 2.60 after using the correction factor calculated from the radiographic examinations.

## **Discussion**

The clinical and radiographic method of caries assessments used in this study were straightforward and robust and offered a good inter- and intra-examiner agreement. Though the methods used might not be sensitive to detect all dental caries, they had a good reproducibility for the purpose of this study. There was a perfect 100% response rate. This good response rate was probably attributed to a clear explanation of the study aim and protocol to the university students. A study report education level would have little effect on caries experience of adolescents (Poorterman et al., 2003). Previous reports also showed the caries status of the Chinese university students was similar to that of the general population with little clinical significant difference (Lo and Chu, 1994; Department of Health, 2002). In addition, their oral hygiene practice and use of dental service were similar to the young adults in Hong Kong (Lo and Chu, 1994; Department of Health, 2002). This sample of students were representative for a wide range of socioeconomic groups in Hong Kong and the distribution was similar to that of a survey of a population (Hagg et al., 2001). However, the present sample chosen could not be claimed as a true representative of all young Chinese young adults in Hong Kong.

Like most western and developed countries, a general decline in dental caries prevalence and incidence has been observed in Hong Kong. Water fluoridation was implemented in 1967. Most young adults in Hong Kong brush at least daily with fluoride toothpaste (Department of Health, 2002) and the vast majority of the toothpastes commercially

available contained fluoride. The decline of caries prevalence accompanies by a change in carious lesion behaviour, probably due to the increased availability of fluorides. Macroscopic cavitation is visually detected at a much later stage in the process while dentin lesion 'hides' under the enamel. Thus, clinical examination alone leaves much to be desired when used as a sole diagnostic method for caries detection and monitoring. Results of this study indicate that the prevalence of dental caries lesion extending to dentin can be considerably underestimated on the basis of clinical examination only. Around half of dental caries passed the clinician's eyes without detection in this study. Based on the finding, it is postulated that the degree of uncertainty accompanying clinical epidemiological research can be large and results with respect to the prevalence of caries need to interpret with caution.

The present epidemiological data show that bitewing radiograph is useful for the detection of caries lesions extending to dentin level in this population of young Chinese adults. Clinical examination alone detected about one-third of the total number of caries, and bitewing examination alone detected about half of these lesions. This result is to certain extent in line with the conclusion reached by an epidemiological study which concluded that the prevalence of dental caries and inadequate restorations was highly underestimated without the use of bitewing radiographs (Poorterman et al., 1999). Based on the additional bitewing radiographic information, the number of teeth in need of restorative treatment due to caries or an inadequate restoration in this study was doubled. As the percentage of undiagnosed carious lesions found in this study was quite high, it seems that radiographs are useful. The over-all underestimation of carious lesions in a routine epidemiological survey results in reporting a significantly lower number of decayed teeth in need of restorative treatment, in that way underlining the clinical value of the survey. This is above all relevant when estimating the manpower and resources in planning of community dental service. Adjustment is essential to cope with the true demand of dental treatment.

Since the process of planning, preparation and the realisation of fieldwork are usually time consuming and expensive, the results obtained from such epidemiological surveys need to be as accurate as possible. If the well planned results lack accuracy, such surveys can just as well be contested from a society perspective. Bitewing radiographs are considered useful for the detection of radiographically deep lesions that would remain undetected by clinical methods alone. A study also demonstrated the necessary of Bitewing radiograph in caries detection of adolescents (Poorterman et al., 2002). However, the use of X-rays in an

epidemiological survey is controversial. It is advocated that radiographs should not be used purely for epidemiological purposes, unless the films are also clinically justified and available to clinician who are caring for the individuals concerned (Kidd et al, 1993).

By adding a radiographic factor in the decayed teeth component (DT) in the caries experience, a more realistic amount of dental caries is reported. This phenomenon also has an effect on the caries experience (DMFT index score) reported in routine surveys. The correction factor based on the additional radiographic information of the carious lesion obtained in this study is 1.13. This correction factor for DMFT index is in line with an epidemiological survey in which the correction factors of caries experience of the two age groups of 17 and 20 years old varies from 1.12 to 1.06 (Poorterman et al., 2000b). It is also suggested that the correction factor was largely dependent on the caries prevalence, age of the participants, average fluoride use in the population, and the amount of restorative treatment. Therefore, correction factors have to be determined for various study populations. This being done, the clinical data can be adjusted in order to obtain a better estimate of the true caries prevalence in the population. The further use of bitewing radiographs in epidemiological surveys of the same population might be unnecessary.

## **Conclusion**

This study found that the use of just clinical information has led to an underestimation of the number of carious teeth. Almost 50% of carious lesions of this group of young Chinese adults passed the examiner's eyes without examination of the bitewing radiographs. Based on this study it can be postulated the degree of uncertainty accompanying clinical epidemiological research can be large and results and conclusions with respect to the prevalence of caries should be interpreted with caution.



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Table 1 Number and percentage of caries detected by clinical and radiographic examination

Caries detected by	Clinical examination only	Clinical or radiographic examination	Radiographic examination only	All caries detected
Number	40	15	58	113
Percentage	35.4	13.2	51.4	100

Table 2 Detection of carious caries from clinical and radiographic examination

		Bitewing Examination		Total
		Negative	Positive	
Clinical Examination	Negative	3049	58	3107
	Positive	40	15	55
Total		3089	73	3162

( $X= 143.6$ ,  $df=1$ ,  $p<0.001$ )

Table 3 Increase in number of decayed teeth (DT) and caries experience (DMFT) after radiographic (Bw) judgement.

Clinical exam		Clinical + Bw exam		Increase in	
DT	DMFT	DT	DMFT	DT (%)	DMFT (%)
0.28	2.31	0.57	2.60	0.29 (104%)	0.29 (13%)