Effect of Illumination on the Accuracy of Identifying Interproximal Carious Lesions on Bitewing Radiographs

(Effet de l'éclairage sur l'exactitude du diagnostic des lésions carieuses interproximales sur les radiographies rétrocoronaires)

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Sommaire

Contexte : *Les dentistes utilisent habituellement un négatoscope comme source principale d'éclairage pour examiner les radiographies. Cependant, les sources secondaires (c.à d., la lumière produite par une source autre que le négatoscope) peuvent réduire le contraste radiographique et nuire ainsi à l'exactitude du diagnostic.*

Objectif : *Déterminer si l'exactitude du diagnostic des lésions carieuses interproximales apparaissant sur les radiographies rétrocoronaires varie en fonction du niveau d'éclairage secondaire.*

Méthodologie : *Quatorze dentistes ont examiné, sous un éclairage secondaire maximal (milieu éclairé) et minimal (milieu sombre), des radiographies rétrocoronaires montrant des lésions interproximales simulées sur des dents artificielles.*

Résultats : *Aucune différence significative* (p = *0,07) n'a été observée entre l'exactitude du diagnostic des lésions carieuses interproximales simulées sur les radiographies rétrocoronaires, selon que l'examen a été fait en milieu éclairé (exactitude moyenne : 72 % ± 12 %) ou sombre (75 % ± 12 %).*

Importance clinique : *L'examen des radiographies rétrocoronaires sur un négatoscope placé dans la salle opératoire permet un diagnostic exact des lésions carieuses interproximales.*

Mots clés MeSH : *dental caries/radiography; lighting; observer variation*

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The accurate diagnosis and treatment of dental caries remain integral components of general dental practice. Carious lesions on the interproximal (i.e., mesial and distal) surfaces of teeth often go undetected with simple visual inspection. In such cases, caries information that is not clinically evident is best obtained via radiography, specifically bitewing radiographs.[1]

The standard technique for examining radiographs is to place the image on a viewbox, which illuminates the anatomic structures by shining light directly through the radiograph. The viewbox thus acts as the primary source of illumination. Secondary sources of illumination (i.e., light other than that originating from the viewbox), such as overhead indoor light or natural outdoor light, can reduce the radiographic contrast and may therefore affect the viewer's ability to extract accurate diagnostic information.

The purpose of this study was to determine if the accuracy of identifying interproximal carious lesions on bitewing radiographs depends on the level of secondary illumination. Two conditions were investigated: the light condition, in which secondary illumination of radiographs was maximized, and the dark condition, in which secondary illumination was minimized. On the basis of the results obtained, recommendations for examining patient radiographs are made.

Materials and Methods

Caries Model

A series of 10 dentition phantoms, with accompanying bitewing radiographs, served as the basis for the study; the models had been constructed and radiographed previously for a separate study, as described in detail elsewhere.[2] Briefly, 60 extracted human teeth (40 premolars and 20 molars) were visually inspected and verified to be free of carious lesions. The teeth were arranged in plaster blocks to simulate 10 maxillary left quadrants and 10 mandibular left quadrants, which were then joined to form 10 left dentition phantoms. Each phantom contained 10 interproximal surfaces available for study: the mesial and distal aspects of the first and second premolars and the mesial aspect of the first molars, for a total of 100 surfaces. Simulated interproximal carious lesions were created by randomly drilling holes with plain carbide burs (1/4 or 1/2 round) on 64 of the 100 available surfaces at the point of contact; the depth of each hole was less than or equal to the depth of the bur. One bitewing radiograph of each phantom was obtained with Kodak Ultraspeed dental film (Eastman Kodak Corporation, Rochester, New York); the Trophy 70-X intraoral x-ray unit was operated at 70 kVp and 8 mA, a 0.7 × 0.7 mm focal spot was used, and total filtration was 2.5 mm aluminium equivalent. All radiographs were processed in the same session, for which fresh chemicals were used; an unexposed film was processed before and after the series of exposed films to ensure equivalent densities.

Viewing Conditions

The primary source of illumination for the examination of radiographs was a portable viewbox (operating at 110 V, 60 Hz and 0.18 A).

For the light condition, sources of secondary illumination were maximized as follows:

- The radiographs were mounted in a clear (lucent) plastic frame.
- The viewbox was placed adjacent to a window during peak daylight hours (12:00 noon to 1:00 p.m.).
- All overhead lights were switched on.
- The door to the room was kept open.

For the dark condition, sources of secondary illumination were minimized as follows:

- The radiographs were mounted in an opaque plastic frame.
- The viewbox was placed in a room without windows (the darkroom).
- All overhead lights were switched off.
- The door to the room was kept closed.

Instructions to Participants

Fourteen dentists, all general practitioners, volunteered to examine the bitewing radiographs on 2 separate occasions: first in the light condition and subsequently in the dark condition, with a minimum interval of 1 week between the examinations. Dental specialists were excluded from the study group to minimize heterogeneity of caries diagnostic ability.

The participants were instructed to identify all simulated interproximal carious lesions, irrespective of size. A time limit of 10 minutes was imposed for each radiographic examination, to mimic actual clinical conditions and prevent unrealistically zealous scrutiny of the radiographs.

Data Analysis

The accuracy of identifying simulated interproximal carious lesions (as a percentage) was determined for each examination; mean values (with standard deviation) were then calculated for the light and dark conditions. Student's *t*-test (paired, 2-sided) was used to identify a significant effect of secondary illumination on mean estimates of accuracy. A probability value (p) less than 0.05 was considered statistically significant.

Results

There was no significant difference ($p = 0.07$) in the accuracy of identifying simulated interproximal carious lesions on bitewing radiographs in the light condition (72% ± 12%, range 52% to 86%) and the dark condition (75% ± 12%, range 48% to 92%). Overall, 4 of the 14 observers displayed greater accuracy in the light condition, 8 displayed greater accuracy in the dark condition, and 2 displayed equal accuracy in the 2 viewing conditions.

Discussion

Minimizing sources of secondary illumination by using an opaque (instead of lucent) plastic frame to mount radiographs, reducing exposure to natural outdoor light and reducing exposure to artificial indoor light did not affect the accuracy of identifying simulated interproximal carious lesions on bitewing radiographs of extracted human teeth.

The following points are also of interest:

- Only 8 (57%) of the participants displayed greater accuracy in the dark condition than in the light condition.
- The lowest (48%) and highest (92%) individual estimates of accuracy in the dark condition were almost identical with the corresponding estimates in the light condition (52% and 86%, respectively).

Taken together, these observations suggest that there are no clinical benefits to controlled darkroom viewing for the radiographic identification of interproximal carious lesions. Furthermore, the present findings are consistent with those of a similar study,[3] in which the level of background lighting did not affect observers' ability to radiographically detect simulated interproximal carious lesions.

This study had several limitations. First, the sample size was relatively low; the precision of the results would be improved with a greater number of participants. Second, the effect of frame opacity on estimates of accuracy was not investigated. To establish the influence of this variable, it would have been necessary to test the 2 frame types (lucent and opaque) in both the light and the dark conditions. Third, the

results were biased by the fact that simulated interproximal carious lesions do not exactly mimic naturally occurring lesions. However, as explained by Dagenais and Clark[2]: "Although we are aware that drilled holes have limitations in terms of simulation of dental caries … the attributes of uniformity of shape and size have advantages in terms of the statistical analysis." This argument is invoked as the basis for extrapolation of the present results to real carious lesions on human teeth in vivo.

The importance of strong primary illumination in dental radiology has been confirmed experimentally: a pair of studies found that use of a viewbox yields higher diagnostic quality than room lighting alone.[4,5] Indeed, dentists generally examine radiographs on a viewbox installed in the operatory. It is suggested that this viewing condition, even in the presence of high levels of secondary illumination (e.g., strong overhead lighting or natural daylight) is adequate for accurately identifying interproximal carious lesions on bitewing radiographs. ◆

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