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Influence of notebook computers screens and undergraduate level of dental students in the radiographic detection of carious lesions

Rafaela Ramos Fernandes[1], Eduarda Alberti Bonadiman[2], Teresa Cristina Rangel Pereira[3], Claudia Batitucci dos Santos Daroz[4], Sergio Lins de-Azevedo-Vaz[5*]

[1] DDS, Federal University of Espírito Santo, Espírito Santo, Brazil.

[2] MSc student, Dental Sciences Graduate Program, Federal University of Espírito Santo, Espírito Santo, Brazil.

[3] Professor, Departament of Clinical Dentistry, Federal University of Espírito Santo, Espírito Santo, Brazil.

[4] Professor, Departament of Dental Prosthesis, Federal University of Espírito Santo, Espírito Santo, Brazil.

[5] Professor, Dental Sciences Graduate Program, Federal University of Espírito Santo, Espírito Santo, Brazil.

Corresponding author:
Dr Sergio Lins de-Azevedo-Vaz
Dental Sciences Graduate Program,
Federal University of Espírito Santo (UFES)
Av. Marechal Campos 1468,
Maruípe Vitória, ES 29043900 Brazil
Email: sergio.vaz@ufes.br

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Aim: To evaluate the influence of notebook computers screens and undergraduate level of dental students in the radiographic detection of carious lesions. **Methods:** Bitewing digital radiographs were presented to 3rd and 5th year dental students in three different notebooks computers: Notebook 1 with anti-glare screen (1366×768 pixels), Notebook 2 without anti-glare screen (1366×768 pixels), and Notebook 3 with anti-glare screen (1920×1080 pixels). A reference standard based on a consensus analysis was set by three senior professors of Oral Radiology and Cariology. Sensitivity, specificity and accuracy values were measured and submitted to two-way ANOVA at a significance level of 5%. **Results:** Notebook 2 provided significantly lower sensitivity values (Mean 56.5% ± 2.94) than notebook 3 (71.1% ± 2.82) ($p = 0.002$). We found no statistically significant differences between the two undergraduate years ($p > 0.05$). **Conclusion:** The anti-glare screen of notebook computers screens can influence the radiographic detection of carious lesions, but the undergraduate level of dental students does not influence this diagnostic task.

Keywords: Dental caries. Radiography, dental, digital. Students. Diagnostic imaging.

Introduction

The diagnosis of carious lesions is a fundamental procedure for the treatment plan, which should focus on recovery, maintenance, and promotion of oral health. The diagnosis of caries' multifactorial nature and complex process of installation is challenging[1]. Visual diagnosis can be subjective in some situations, such as the detection of inactive carious lesion, discoloration on enamel, and hidden caries[2,3]. Moreover, lesions confined to the enamel may only be radiographically evident when 40% or more of mineral loss occurs[4]. Nevertheless, radiographs are crucial for diagnosis, treatment plan, and follow-up of patients.

The introduction of technological advances of digital dental radiography allowed the development of several systems currently available for the clinical management of carious lesions[5]. The screens in which dentists assess digital radiographs may or may not influence the diagnosis of carious lesion, as reported in previous studies[6-8]. The factors that determine the fidelity of the screen, that is, its reproduction accuracy, include the screen resolution (number of vertical lines, bandwidth, and rate of update), bit depth, dot density, luminance, screen size, and anti-glare features[9]. Cederberg et al.[6] (1999) did not find influence of desktop and notebook computers screens on the observer performance to detect carious lesion. However, Isidor et al.[7] (2009) found statistically significant differences among desktop screens, with the best results attributed to higher resolution screens. Thus, notebook computers allow more flexibility to assess digital radiographs regarding mobility than desktops[10].

In addition to the influence of the screen used for radiographic interpretation, another important factor is the clinical experience of the examiner[11]. Increased experience may decrease misdiagnosis, as observed by other authors. These studies reported higher values of sensitivity, specificity, and accuracy in examiners with greater experience, both in undergraduate, graduate, and professional settings[12-14].

We did not find broad approach comparing different types of notebook computers screens, especially with anti-glare features, for radiographic detection of carious lesions in an undergraduate setting. Thus, this study aimed to show the influence of notebook computers screens and the undergraduate level of dental students in the radiographic detection of carious lesions.

Materials and Methods

This cross-sectional observational study was previously approved by the local Institutional Review Board (CAAE 89333218.5.0000.5060). A total of 50 dental students from a Brazilian Federal University participated in the study. The inclusion criteria were: students from the 3rd and the 5th graduation year, regardless of gender and age. All students who met the criteria for inclusion were invited to participate as volunteers after reading and signing the informed consent form.

Seven bitewing digital radiographs with minimal distortion and medium degree of contrast and density were retrieved from the local Oral Radiology Center database and arranged in slides of the Microsoft Power-Point software (Microsoft Corporation, Redmond, WA, USA) (Figure 1). Under consensus, three senior professors of Oral Radiology and Cariology simultaneously assessed the radiographs, clinical photographs, and clinical files of the cases regarding the presence or absence of carious lesions. The professors assessed the radiographs in a silent, dim-light room, using a dedicated monitor (FlexScan EV2456, EIZO Corporation, Ishikawa, Japan). They assigned a score of 0 for absence and 1 for presence of carious lesion for each tooth surface (mesial, occlusal, and distal). The answers of the professors were tabulated in a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA) and integrated the reference standard. Finally, a sample number of 48 tooth surfaces was used in the study.

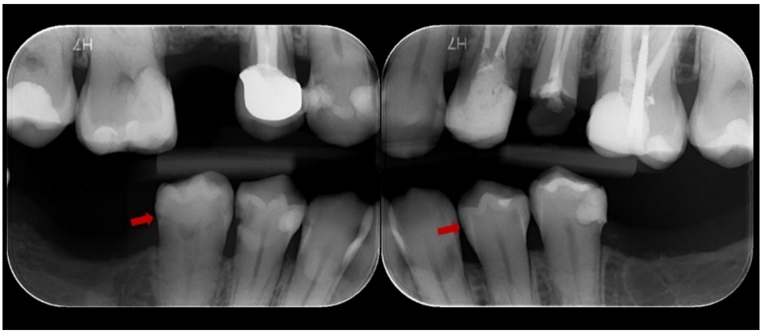

Figure 1. Examples of bitewing digital radiographs used in the study. Arrows indicate surfaces to be assessed.

After setting the reference standard, the students were randomly assigned to three different notebooks computers to independently assess the same radiographs: Notebook 1 with anti-glare screen (WXGA resolution 1366x768 pixels) (Dell Latitude E5470, Dell Inc., Round Rock, TX, USA), Notebook 2 without anti-glare screen (WXGA resolution 1366x768 pixels) (Positive Master, Positivo, Curitiba, PR, Brazil), and Notebook 3 with anti-glare screen (FULL HD resolution 1920×1080 pixels) (HP ProBook 440 G3, Hewlett-Packard Company, Palo Alto, CA, USA). All the notebooks computers had a 14” screen size. The assessments took place in a silent, dim-light room, and the students were given a numerical code so that they would not be identified at any stage of the research. The students had no access to the reference standard or clinical photographs of the cases. The answers of the students were also tabulated in a spreadsheet (Microsoft Excel, Microsoft Corporation, Redmond, WA, USA).

All students reassessed 20% of the sample to measure intra-examiner reproducibility by using the Kappa test, with the following interpretation[15]: poor reproducibility (<0.00), light (0.00-0.20), fair (0.21-0.40), average (0.41-0.60), substantial (0.61-0.80), and almost perfect (0.81-1.00).

Using the answers provided by the students and the reference standard, the values for sensitivity (proportion of a positive diagnosis given to the presence of carious lesions); specificity (probability of not having caries given its absence); and accuracy (proximity of results to its actual reference value) were calculated for each student using an online calculator (Eng J. ROC analysis: web-based calculator for ROC curves, Johns Hopkins University). These values were subjected to two-way ANOVA with Tukey's post-hoc test at a significance level of 5%, using the Jamovi software (The jamovi project, 2021). The hypothesis tested was that the diagnostic values would be higher in the group of students whose notebook computers has an anti-glare screen (notebooks 1 and 3) and whose undergraduate level is the most advanced (5th year).

Results

Intra-examiner reproducibility was moderate for the 3rd year (Kappa = 0.54) and fair for 5th year students (Kappa = 0.27).

Table 1 shows the number of students per experimental group (graduation year and notebook screen). A total of 58% attended the 3rd graduation year and, in general, we evenly distributed the students among the three notebooks computers.

Table 1. Absolute and relative frequency of participants in the experimental groups (graduation year and notebook screen).

Graduation year	Notebook screen	N (%)	Total – N (%)
3rd	1	9 (18%)	29 (58%)
	2	11 (22%)	
	3	9 (18%)	
5th	1	7 (14%)	21 (42%)
	2	6 (12%)	
	3	8 (16%)	

1. Anti-glare screen (1366×768 pixels); 2. No anti-glare screen (1366×768 pixels); 3. Anti-glare screen (1920×1080 pixels); N. Absolute frequency; %. Relative frequency.

Table 2 shows the mean and standard deviation values for sensitivity, specificity, and accuracy to each experimental group, and the results of ANOVA. We identified no statistically significant differences between 3rd and 5th year students ($p > 0.05$). However, the factor "notebook screen" had statistically significant differences for the values of sensitivity ($p = 0.003$), which stood for the students' ability to radiographically identify the carious lesions. According to Tukey's post-hoc test, notebook 2 presented significantly lower sensitivity than the notebook 3 ($p = 0.002$). The interaction between the factors "graduation year" and "screen type" had no statistically significant differences ($p > 0.05$).

Table 2. Mean and standard deviation values for sensitivity, specificity, and accuracy for each experimental group (graduation year and notebook screen).

Factor under study	Group	Sensitivity (SD)	Specificity (SD)	Accuracy (SD)
Graduation year[ns]	3rd	62.4 (2.16)	79.6 (2.57)	71.7 (1.20)
	5th	66.1 (2.55)	77.9 (3.03)	72.5 (1.41)
Notebook screen*	1	65.2 (2.92)	80.5 (3.47)	73.5 (1.62)
	2	56.5 (2.94)**	79.7 (3.49)	69.0 (1.63)
	3	71.1 (2.82)	76.1 (3.34)	73.8 (1.56)

1. Anti-glare screen (1366×768 pixels); 2. No anti-glare screen (1366×768 pixels); 3. Anti-glare screen (1920×1080 pixels); SD. Standard deviation.
ns. The values for sensitivity, specificity, and accuracy had no statistically significant differences ($p > 0.05$) for the factor “graduation year”. *The sensitivity values were statistically different for the factor “notebook screen” ($p = 0.003$). **Statistically lower than sensitivity for the notebook 3 according to the Tukey post-hoc test ($p = 0.002$). The interaction between the factors “graduation year” and “notebook screen” had no statistically significant differences ($p > 0.05$).

Discussion

Computers are an integral part of our personal and professional lives, resulting in the introduction of computers and personal electronic devices in the domains of teaching and learning[16]. In Oral Radiology, the use of this type of technology became important due to the increasing use of digital images[17].

In this study, we assessed the influence of different notebook computers screens and undergraduate level in the interpretation of digital radiographs for the diagnosis of carious lesions. The use of a notebook computer without anti-glare screen resulted in lower sensitivity compared to a notebook computer with anti-glare screen and spatial higher resolution. This result suggests that the screen quality might impact in the radiographic interpretation, mainly in the identification of carious lesions.

Moreover, the values obtained with the use of the two notebooks computers with anti-glare screen had no statistically significant differences, thus, the important factor for the best interpretation of digital radiographs might be the presence of the anti-glare screen and not the screen resolution. The values of specificity and accuracy had no statistically significant differences too.

Conflicting results on screens’ influence in radiographic interpretation are reported[6-8]. Some studies[6,8] did not find any influence of the screen in the diagnosis of carious lesions; Isidor et al.[7] (2009), in turn, found statistically significant differences among the screens studied. In their study, the newest and best quality screen had statistically higher diagnostic values than the other two screens studied[7], which corroborates our results. A previous study also found that computer screen does not influence the subjective assessment of radiographic contrast, but a 90º horizontal viewing angle and a high ambient light benefit it[18]. Nevertheless, we opted to use a dimly light room since this is a recommendation for a radiological setting.

The radiographic interpretation is a high cognitive activity, mainly based in the knowledge acquired by the observer and in their clinical experience. Studies indicate that the examiner's clinical experience influences the ability to radiographically detect carious lesions[12,13]. These data contrast with our results, since students of distinct graduation years delivered no statistically significant different diagnostic values for the radiographic detection of carious lesions.

Other authors reported no statistically significant differences between students who received and did not receive additional training regarding their diagnostic ability to radiographically detect proximal carious lesions[11,19]. Moreover, one additional year of clinical experience did not influence the radiographic detection of oral pathologies and the establishment of differential diagnoses[20]. These studies corroborate our findings when comparing the values provided by the 3rd and 5th year undergraduate students, since we found no statistically significant differences for these.

The accuracy of digital radiography for the carious lesion detection was previously reported at 68%[21]. We found similar mean values for the 3rd year (71.7%) and the 5th year (72.5%) dental students.

The limitations in this study include the absence of other groups with different expertise, such as general practitioners and radiologists, to compare with the group of dental students. Future studies can consider such comparisons.

Conclusion

In conclusion, the undergraduate level of dental students did not influence their ability to radiographically detect carious lesions. However, a screen with anti-glare features can positively influence this diagnostic task.

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Conflicts of interest

None.

Data Availability

Datasets related to this article will be available upon request to the corresponding author.

Author Contribution:

Data collection and manuscript writing: Rafaela Ramos Fernandes, Eduarda Alberti Bonadiman. Have revised and approved the final version of the manuscript: Teresa Cristina Rangel Pereira, Claudia Batitucci dos Santos Daroz, Sergio Lins de-Azevedo-Vaz

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