ORIGINAL ARTICLE

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Training for systematic oral examination improves the detection of simulated lesions in the oral mucosa

Abstract:

Objective: Evaluate the effect of systematic oral examination training on the accuracy of detecting simulated oral lesions among dental surgeons (DDS) and dental students (DS). **Methods:** Twenty-seven DDS (with >2 years' practice) and 10 final-year DS were randomized into control and intervention groups. The intervention group attended a lecture on oral cavity anatomy and a systematic examination protocol. Simulated patients, without oral lesions or prostheses, had black dots applied to their mucosa. Participants examined these patients and recorded any detected lesions and their locations. **Results:** In the intervention group, DDS detected lesions at a median rate of 90%, significantly higher than 75% in controls (p=0.01). Similarly, DS in the intervention group achieved a median detection rate of 90% versus 80% in controls. Furthermore, DDS in the intervention group were significantly more accurate in localizing lesions on the floor of the mouth (p=0.004), right maxillary tuber (p=0.01), upper labial mucosa (p=0.01), and lower jaw right vestibule (p=0.004). **Conclusion:** Systematic oral examination training significantly enhances the accuracy of simulated oral lesion detection, particularly in critical anatomical regions. These findings support the value of targeted training for improving diagnostic skills among dental practitioners and students.

Keywords: Oral diseases; Conventional oral examination; Diagnosis; Screening.

INTRODUCTION

Oral squamous cell carcinoma (OSCC) is among the most common human cancers and is associated with low rates of 5-year survival[1]. This malignancy may arise from oral potentially malignant disorders (OPMD), which are lesions of the oral mucosa with an increased risk of progression with malignant transformation in comparison to other benign lesions or with the normal oral mucosa[2]. The poor prognosis of OSCC is associated with advanced disease stages[3] as a consequence of delayed diagnosis[4]. In addition to interrupting and preventing exposure to risk factors, such as tobacco smoking, the screening for early detection of OSCC and OMPD is a cornerstone for preventing this disease and improving patients' outcomes[4].

The conventional oral examination (COE) can detect OSCC and OPMD and should be part of routine oral examination by dental surgeons[5]. The recommendation for COE performance is that it must include the systematic evaluation of all oral mucosa surfaces[6]. Nevertheless, sensitivity and specificity of COE to detect OSCC and OMPD remain unsatisfactory[7], with a significant portion of OSCC and OPMD cases being missed[8]. Several screening programs for early detection of OSCC and OPMD are routinely or periodically performed with results reported in the literature, however, there is still a lack of evidence that these programs result on a reduction of oral cancer mortality[9,10].

Statement of Clinical Significance
By adopting a standardized approach to examining all anatomical regions of the oral cavity, practitioners can improve early identification of oral diseases. The findings emphasize the critical need for incorporating structured training into routine dental education and continuing professional development to improve the diagnosis of oral lesions.

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This problem may reflect a lack of training for realizing an oral examination properly, following a standardized sequence of anatomical structures examined in order to cover all oral mucosal surfaces. This deficiency is poorly explored as reported on a systematic review indicating that most screening studies for OSCC and OPMD fail to report a calibration of examiners and the method of oral examination[5]. The adoption of adjunctive tools to improve oral lesions detection as fluorescence-based methods[11] are reported but lack substantial evidence on population screening-based studies, besides increasing costs and requiring additional training of examiners.

Given the low performance of population screening studies to detect these oral lesions, the need to identify the deficiencies on COE and methods to improve it is evident. In this study we addressed the effect of standardizing the COE on the detection rates of oral simulated lesions by general dental surgeons and dental students.

METHODS

Ethical considerations

Confidentiality of participants in this study was ensured through a stringent anonymization process. The data collection forms did not include any personal or identifiable information about the participants. The study was approved by the *Universidade Brasil* Ethics Committee (79871824.4.0000.5494). Informed consent was obtained for all participants.

Study design, setting and participants

This interventional study was adapted from Puladi et al.[12] and included the participation of general dental surgeons (DDS) and dental students (DS) and was performed on the dental clinics of the *Universidade Brasil*, Fernandópolis (SP), Brazil.

Inclusion criteria for DDSs were:

a) at least two years of practice as general dental surgeon;
b) current practice on primary care setting, and
c) accept to participate in the study voluntarily by signing informed consent.

Inclusion criteria for DSs were:

a) to be currently on the last year of dental school;
b) to have passed their oral medicine/stomatology and oral pathology courses without any failures; and
c) accept to participate in the study by signing informed consent.

To reduce bias, participants were not informed of the study's true objective; instead, they were told that the experiment aimed to evaluate their oral examination practices on routine diagnostic procedures. After the experiment, all participants were made aware of the objectives of the study.

Randomization

Figure 1 details the flowchart of the study. In total, 27 DDS and 10 DS were included in the study. Intervention and data collection were performed on a single day. Each participant was designated with a numerical code which were entered on Microsoft Excel®. Participants of each group were randomized into two study groups using a randomization function. Thus, a control group for DDSs was composed of 13 participants, a control groups of DS was composed of 5 participants, an intervention group of DDSs was composed of 14 participants, and an intervention group of DS was composed of 5 participants (Figure 1).

Simulated lesions

Ten healthy volunteers were selected as simulated patients. Regardless of sex and age, the criteria for participating as a simulated patient were:

a) to have all natural teeth (except third molars) without active caries lesions;

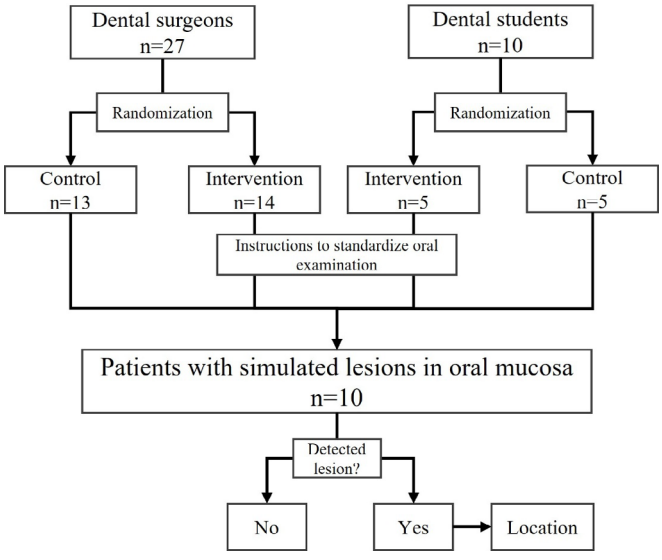

Figure 1. Flowchart of the study.

b) do not use orthodontic appliance or dental prosthesis;
c) do not have any detectable lesion in the oral mucosa in the day of the exam;
d) voluntarily accept to participate in the study by signing informed consent.

Using a non-toxic waterproof marker of black color (Overseas®), round dots of approximately 3mm in diameter were drawn in different anatomical regions of the simulated patients (each simulated patient received 1 simulated lesion). Anatomical locations of dots are detailed in Figure 2.

Intervention: instructions to perform a systematic oral examination

Participants of the intervention groups (DDS=14; DS=5) received a 30-minute lecture — without a practical component — on oral cavity anatomy and instructions for performing a systematic oral examination, as per recommended by Reichert and Philipsen[13].

The sequence of the oral examination recommended to participants of intervention groups was:

1) Lips [lower and upper];
2) Vestibule [upper and lower lip mucosa, right and left buccal mucosa];
3) Gingiva [vestibular and lingual, upper and lower];
4) Tongue [dorsum and border];
5) Floor of mouth and ventral tongue;
6) Palate [hard and soft];
7) Retromolar region [left and right];
8) Throat.

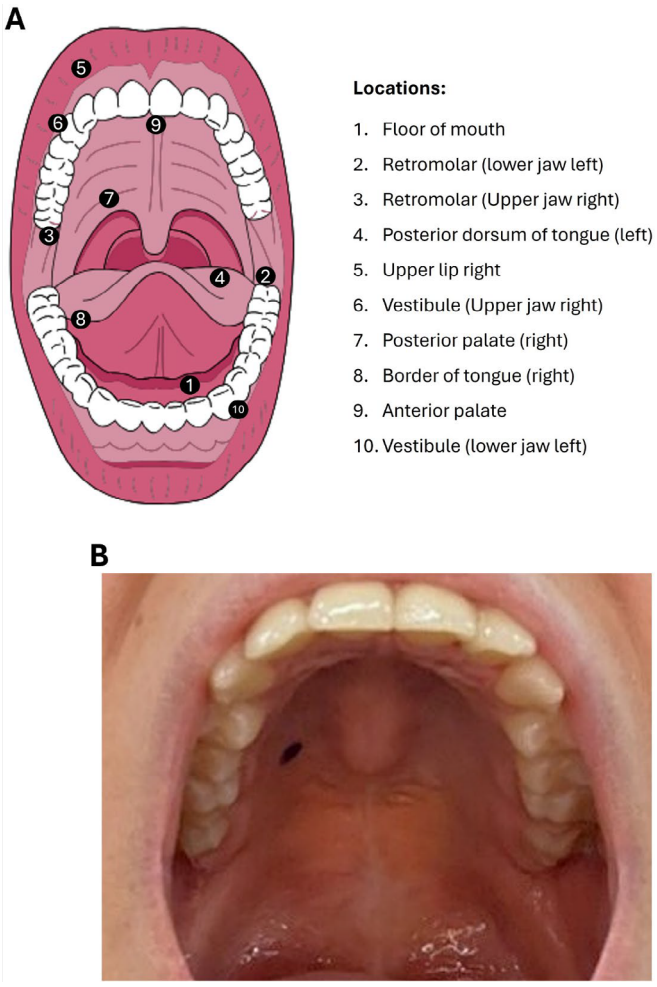

Figure 2. (A) Representation of the simulated lesions locations in oral mucosa. (B) Example of simulated lesion in the right palate.

Oral examination

Participants of all groups were tasked to perform an oral examination on all simulated patients but were not aware of the nature of alterations they were looking for (black dots). Participants of the control groups (DDS=13; DS=5) did not receive any training prior to this step. The simulated patients were positioned on dental chairs, and each box contained gloves, gauze, and dental mirror available for examinations. Each participant had 3 minutes to perform the oral examination of each simulated patient, and report if they detected any simulated lesion and, if positive, describe the location of the lesion detected. Volunteer simulated patients were instructed to not interact verbally with the examiners and were not aware of which group each examiner was designated to.

Statistical analysis

Demographic and professional characteristics of participants are presented by descriptive analysis. After Kolmogorov-Smirnov normality test, the median of detection of simulated lesions were compared by the Kruskal-Wallis test followed by Dunn's posthoc test corrected by Bonferroni's method. The effect size of Kruskal-Wallis test was calculated by the epsilon^2 (ε^2) method and classificated as small ($\varepsilon^2 \approx 0.01$), medium ($\varepsilon^2 \approx 0.06$), or large ($\varepsilon^2 > 0.14$)[14]. The rate of detection of lesions in the correct location by the groups, and comparison of demographic and professional practice characteristics between control and intervention groups was performed by the Chi-square test or Fisher's exact test. Analyses were performed using the GraphPad Prism 8.0®. $p<0.05$ were considered statistically significant.

RESULTS

Participants' characteristics

Demographic and professional practice features of participants are detailed in Table 1.

For DDS participants, the mean age was 42.1 years, ranging from 23 to 60. Most participants in both the intervention and control groups were female, and the majority had more than 10 years of experience. For DS participants, the mean age was 22.1 years, ranging from 19 to 30, and most participants of control and intervention groups were female.

Detection of simulated lesions

The rate of detection of simulated lesions was significantly different across the groups ($H_{[df=4, n=37]}=11.46$, $p=0.009$, $\varepsilon^2=0.318$) (Figure 3). median of detection of simulated lesions for DDS-control was 75%, 90% for DDS-intervention, 80% for DS-control, and 90% for DS-intervention. Multiple comparison analysis demonstrated that the rate of detection of simulated lesions was significantly higher for DDS-intervention than for DDS-control ($p=0.01$) (Figure 3).

Detection of simulated oral lesions according to anatomic location

Table 2 presents the rate of detection of simulated lesions in the correct location according to the

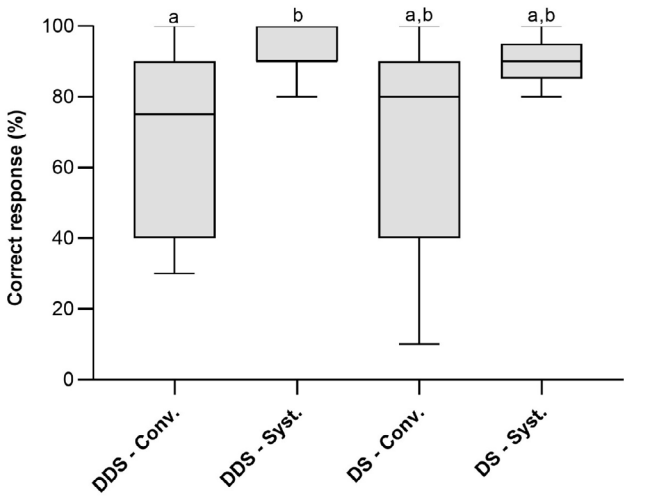

Figure 3. Box plot of the distribution of the rates of simulated oral lesions detection by general dental surgeons and dental students from control (DDS-Conv. and DS-Conv., respectively) and intervention (DDS-Syst. and DS-Syst., respectively) groups.

Table 1. Demographic and professional practice data of participants.

	DDS-Conv.	DDS-Syst.	p-value*	DS-Conv.	DS-Syst.	p-value*
	n (%)	n (%)		n (%)	n (%)	
Age						
Range (mean)	23–60 (42,1)		0.49	19–30 (22.1)		0.66
Sex						
Male	1 (3.7)	2 (7.4)	0.47	0 (0)	2 (20)	0.22
Female	13 (48.1)	11 (40.7)		5 (50)	3 (30)	
Time of experience (years)						
2–5	1 (3.7)	2 (7.4)		-	-	
6–10	2 (7.4)	2 (7.4)	0.78	-	-	
>10	11 (40.7)	9 (33.3)		-	-	
Practice área						
Public	10 (37)	6 (22.2)		-	-	
Private	2 (7.4)	4 (14.8)	0.40	-	-	
Public+private	2 (7.4)	3 (11.1)		-	-	
Public primary care						
Yes	9 (33.3)	10 (37)	0.38	-	-	
No	5 (18.5)	3 (11.1)		-	-	

DDS-Conv.: dental surgeons performing conventional oral examination; DDS-Syst.: dental surgeons performing systematic oral examination; DS-Conv.: dental students performing conventional oral examination; DS-Syst.: dental students performing systematic oral examination.
*χ^2 test. Data presented as n (%).

Table 2. Correct detection of simulated lesions in the oral mucosa according to anatomic location by dental surgeons and dental students using conventional or systematic oral examination.

Location of simulated lesion	DDS-Conv.	DDS-Syst.	p-value	DS-Conv.	DS-Syst.	p-value
	n (%)	n (%)		n (%)	n (%)	
Floor of mouth						
Detected + correct	7 (25.9)	13 (48.1)	0.004*	4 (40)	4 (40)	0.778
Non-detected or incorrect	7 (25.9)	0 (0)		1 (10)	1 (10)	
Lower left retromolar pad						
Detected + correct	9 (33.3)	10 (37)	0.385	3 (30)	2 (20)	0.500
Non-detected or incorrect	5 (18.5)	3 (11.1)		2 (20)	3 (30)	
Right maxillary tuber						
Detected + correct	1 (3.7)	7 (25.9)	0.011*	3 (30)	3 (30)	0.738
Non-detected or incorrect	13 (48.1)	6 (22.2)		2 (20)	2 (20)	
Dorsum of tongue						
Detected + correct	7 (25.9)	9 (33.3)	0.267	2 (20)	3 (30)	0.500
Non-detected or incorrect	7 (25.9)	4 (14.8)		3 (30)	2 (20)	
Upper labial mucosa						
Detected + correct	5 (18.5)	11 (40.7)	0.013*	1 (10)	5 (50)	0.024*
Non-detected or incorrect	9 (33.3)	2 (7.4)		4 (40)	0 (0)	
Vestibule (upper jaw right)						
Detected + correct	8 (29.6)	11 (40.7)	0.127	1 (10)	3 (30)	0.262
Non-detected or incorrect	6 (22.2)	2 (7.4)		4 (40)	2 (20)	
Palate (post. right)						
Detected + correct	10 (37)	12 (44.4)	0.186	4 (40)	5 (50)	0.500
Non-detected or incorrect	4 (14.8)	1 (3.7)		1 (10)	0 (0)	
Border of tongue (right)						
Detected + correct	9 (33.3)	12 (44.4)	0.098	2 (20)	4 (40)	0.262
Non-detected or incorrect	5 (18.5)	1 (3.7)		3 (30)	1 (10)	
Palate (anterior left)						
Detected + correct	9 (33.3)	8 (29.6)	0.598	2 (20)	4 (40)	0.262
Non-detected or incorrect	5 (18.5)	5 (18.5)		3 (30)	1 (10)	
Vestibule (lower jaw left)						
Detected + correct	7 (25.9)	13 (48.1)	0.004*	4 (40)	5 (50)	0.500
Non-detected or incorrect	7 (25.9)	0 (0)		1 (10)	0 (0)	

DDS-Conv.: dental surgeons performing conventional oral examination; DDS-Syst.: dental surgeons performing systematic oral examination; DS-Conv.: dental students performing conventional oral examination; DS-Syst.: dental students performing systematic oral examination.
*Statistically significant (χ^2 test).

anatomical location (dots). For DDS participants, the intervention group was significantly more prone to detect the simulated lesions in the correct anatomical location than control group for dots localized on floor of mouth (p=0.004), right maxillary tuber (p=0.01), upper labial mucosa (p=0.01), and lower jaw right vestibule (p=0.004). For DS participants, the intervention group was significantly more prone to detect simulated lesions in the correct anatomical location than control group for upper labial mucosa (p=0.02).

DISCUSSION

The high rates of delayed OSCC diagnosis and its consequent poor prognosis highlight the need for improved detection methods. Despite the performance of several screening programs and development of auxiliary technologies, the COE remains the cornerstone of the detection of early alterations in the oral mucosa[5,15]. Nevertheless, the COE performed by general dental practioners in primary care require attention.

The findings of this study demonstrated that the accuracy of COE is significantly enhanced when dentists follow a standardized sequence of anatomical structures, what has the potential for a significant clinical impact for the early detection of oral diseases, including OSCC and OPMD.

The accuracy of COE to detect oral lesions have been demonstrated to be unsatisfactory and with low impact for the early diagnosis of oral high risk lesions[6,9]. A recent review observed that most studies on screening for oral cancer and OPMD fail to describe an oral examination method, including previous training and calibration of examiners[5], thus it is plausible to infer that there are no criteria to evaluate the efficacy of COE. Despite the potential of improving the detection of oral high-risk lesions with the clinical inclusion of auxiliary methods such as autofluorescence visualization[16], salivary biomarkers[17], and more recently optical coherence tomography[18], these methods still require specific training and calibration of oral health teams, and generate additional costs, what might be a problem for low-income or remote settings. Thus, identifying the challenges behind the performance of COE may improve its accuracy and cost-effectiveness.

In this study, the dentists who did not receive clinical training prior to oral examinations demonstrated a median rate of detection of simulated oral lesions of 75%, which may be satisfactory, but was significantly lower than the median of detection rate for dentists who were trained to perform a systematic examination of oral structures (90%). These results are in accordance with a previous study in which the standardized oral examination had a sensitivity (85.4%) to detect simulated oral lesions significantly higher than controls (78.8%)[12] . Curiously, we observed no differences on the detection rates between controls and standardized oral examination by dental students. Furthermore, the median detection rates of dental students without training prior to examination was slightly higher (80%) than for general dental practioners on control group. This may be because dental students were submitted to training in oral examination more recently on dental school, while general dental practioners might lose criteria to perform oral examination along the years of experience. In this study we did not assess whether DDSs had undergone any training for systematic oral examination after dental school, nevertheless the results obtained reinforce the importance of continuous education.

General dental practioners performing standardized oral examination were significantly more prone to detect simulated lesions on the floor of mouth, right maxillary tuber, upper labial mucosa, and vestibule (lower jaw left) than general dental practioners of the control group, while dental students performing standardized oral examination were more likely to detect the simulated lesion of the upper labial mucosa than dental students of the control group. Puladi et al.[12] observed that most examiners failed to detect a simulated lesion on the upper labial mucosa, followed by the floor of mouth. The consistent results of both studies suggests that these locations deserve better attention from general dental practioners and should be emphasized upon training for oral examination. This is critical because the floor of mouth is a common location for OSCC[19] and the upper lip may be affected by tumors of the minor salivary glands[20].

This study has limitations that must be acknowledged. First, it includes a relatively small sample, what can reduce the generalizability of the results, especially for being a single-center study with a specific population of professionals. The sample size may also influence on the power of statistics, but an effect size test of the Kruskal-Wallis results demonstrated a large effect size (ES) (ε^2=0.318).

Another important limitation is the use of simulated lesions, which may not reproduce the complexity and variety of real oral lesions. However, our method was not intended to simulate a wide spectrum of lesion appearances but rather to assess whether examiners systematically screened all oral mucosa surfaces. The black dots were chosen as standardized and reproducible markers of alteration detection, ensuring that differences in examiners' performance were due to examination thoroughness rather than interpretation of lesion morphology. While real malignant and potentially malignant lesions present with variable colors, textures, and borders, these characteristics may introduce subjectivity in assessment, making it difficult to isolate the effect of examination technique alone. This method ensures that failure to detect a lesion is solely attributable to examination inadequacies rather than clinical diagnostic uncertainty. Despite these limitations, this approach has practical applications in training and assessment. Previous studies have demonstrated that many dental practitioners fail to systematically examine all oral mucosal surfaces[5,12], leading to missed diagnoses. By using a standardized, reproducible method to evaluate examination thoroughness, we provide objective evidence supporting the need for structured training in systematic oral examinations. Future studies could complement this

approach with more advanced simulation techniques, such as 3D oral lesion models or digital simulation tools, to bridge the gap between lesion detection training and real-world clinical diagnosis.

Furthermore, it is important to consider that participants were invited to an experimental setting and knew that they were performing oral examinations under evaluation, which may result in a Hawthorne effect[21]. This is important because dentists may have performed the examinations with more attention than they do in routine clinical practice. Thus, although a significant difference was observed, the simulated oral lesion detection rates for all groups might be overestimated compared to their real clinical routine. Additionally, we did not assess whether the participants consistently adhered to the standardized oral examination sequence throughout the study. While the intervention group was trained to perform the standardized examination, we relied solely on the outcomes of lesion detection as the measure of effectiveness. Future studies could benefit from incorporating assessments to verify whether participants are consistently following the standardized examination steps during the evaluation process, which would provide more robust evidence of the intervention's impact on clinical practice.

CONCLUSION

Standardizing the COE can significantly improve the detection rates of oral lesions by general dental surgeons. This finding suggests that implementing structured training programs on oral examination method may improve the early detection and clinical outcomes for patients at risk of OSCC and OPMD. Further research including this approach on population screening setting is needed to confirm these findings.

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AUTHORS' CONTRIBUTIONS

LES: conceptualization, data curation, formal analysis, investigation, project administration, writing – review & editing. HSB: conceptualization, data curation, writing – review & editing. DFCD: conceptualization, data curation, writing – review & editing. MMALS: conceptualization, data curation, writing – review & editing. ST: conceptualization, data curation, formal analysis, investigation, writing – original draft, writing – review & editing.

CONFLICT OF INTEREST STATEMENT

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Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Ethical statement: This study protocol was approved by the institutional review board of *Universidade Brasil* (Protocol nº. 79871824.4.0000.5494) and followed the Declaration of Helsinki. All participants gave informed and signed permission before beginning assessments for the participation, and divulgation of results in academic publications and presentations.

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