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REVIEW ARTICLE

Detection of Occlusal Carious Lesion using the SoproLife® Camera: A Systematic Review

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ABSTRACT

Aim: The aim of this systematic review was to assess the *in vivo* scientific evidence regarding the ability of a recently developed light fluorescence device, SoproLife® (Sopro-Acteon group, La Ciotat, France) in detecting occlusal carious lesions.

The PubMed database was searched for *in vivo* trials that evaluated the validity of the SoproLife® camera for the detection of occlusal carious lesions. Among the 11 articles originally identified with the keyword "Soprolife," only three articles were included.

The three included surveys used the International Caries Detection and Assessment System (ICDAS)-II criteria as gold standard for the assessment of SoproLife® compared or not to other detection devices (DIAGNOdent® and Spectra Caries Detection Aid®). Two of the included studies reported only on permanent teeth or both primary and permanent teeth. The SoproLife® validity values varied markedly among studies with a sensitivity ranging between 0.43 and 0.95 and a specificity between 0.55 and 1. Interobserver reproducibility with the SoproLife® was reported in two of the three studies (0.98 and 0.72) and none of the studies reported about intraobserver reproducibility.

No clear-cut conclusion can be made based on the three included clinical studies; further *in vivo* investigations are needed to confirm the validity of the SoproLife® camera in terms of detection of occlusal carious lesions.

Keywords: Occlusal carious lesions, SoproLife®, Systematic review.

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INTRODUCTION

Questionable occlusal caries (QOC) are defined as clinically suspected caries, due to the presence of suspicious discoloration and/or anfractuous pits and fissures, with no cavitation or radiographic evidence of occlusal caries. Makhija et al[1] estimated their prevalence in a practice-based network involving 82 dentists and hygienists practicing in the USA and Denmark to 34% of the patients (n = 6,910) and 11% of unrestored occlusal tooth surfaces (n = 50,445). Thus QOC detection is of importance; indeed, if not detected at a noncavitated stage, an occlusal lesion may progress to cavitation prohibiting a strictly noninvasive management by therapeutic sealants.[2]

Nowadays, two validated techniques coexist: The clinical examination based on International Caries Detection and Assessment System (ICDAS) visual criteria and the bitewing radiograph.[3-6] If bitewing radiography has been recognized to provide an accurate detection for proximal caries detection with a sensitivity between 71 and 100% and a specificity (SP) between 99 and 100%,[7] sensitivity (SN) value drops down to 45% for noncavitated enamel occlusal lesions with a reproducibility at 18%, despite a specificity remaining high (83%).[3] Visual examination has a low interest for approximal caries detection,[8] due to the limitation of the visual access and with respect to noncavitated occlusal lesions. For the same reason, it records both low sensitivity (12%) and reproducibility (45%) despite a high specificity (93%).[3] Both techniques have to be combined for an optimized detection of occlusal surfaces with a sensitivity at 49%, a specificity at 87%, and a reproducibility at 46%.[3] Thus new devices based on new technologies have been developed to counteract their limitations with the aim to improve, ideally, the SN, the SP, and the reproducibility. A systematic review endorsed the DIAGNOdent® and DIAGNOPen® (Kavo,

Birberach, Germany) that corresponded to the most widely studied fluorescence devices as a third diagnostic method, especially on occlusal surfaces in permanent molars,[5] despite the supporting evidence graded as low quality according to Guyatt et al[9] GRADE system. Nevertheless, Gomez et al[6] corroborate these results, but they underlined a large variation in SE and SP values due to a lack of consistency in definition of disease, gold standard and analytical methods used in the included studies. Lastly, a recent systematic review demonstrated that four fluorescence-based devices – DIAGNOdent®, DIAGNOPen®, QLF™ (Inspektor BV, Amsterdam, The Netherland), FC® (Vista Proof, Dürr Dental, Germany) – have similar overall performance.[10] Moreover, a trend toward higher pooled SP values than the pooled SE was observed except for the more advanced lesions threshold on the occlusal surfaces of permanent molars (similar values for SE and SP). No study concerning a new light-induced fluorescence evaluator system, the SoproLife® (Sopro-Acteon group, La Ciotat, France), was included in these different systematic reviews. The SoproLife® is one of the recently developed devices; it is based on the optical property of auto-fluorescence of dental tissues when they are illuminated at a 450 nm wavelength.[11-13] The device combines a hight-magnification intraoral camera (of more than 50×; using three illumination modes: daylight, diagnosis mode, and treatment mode) and a detection system that, according to the manufacturer, can detect and locate differences in density, structure, and/or chemical composition of a biological tissue subjected to continuous lighting in one frequency band while making it generate a fluorescence phenomenon in a second frequency band.[12,13]

Thus, the aim of the present systematic review was to evaluate the *in vivo* scientific evidence regarding the validity (SN, SP, reproducibility, and receiver operating characteristic (ROC) curve) of the SoproLife® camera in terms of detection of occlusal carious lesions.

MATERIALS AND METHODS

Criteria for Considering Studies for this Review

The PubMed database was searched in February 2016 for trials that evaluated the *in vivo* validity (SN, SP, reproducibility, and ROC curve) of the SoproLife® camera for the detection of occlusal carious lesions. The search was undertaken with the following keyword: "Soprolife", with no restriction on date. Reference lists of the review articles identified in the search were scanned for further eligible studies.

Data Collection

Eligible articles were based on their compliance with the inclusion criteria, namely: (1) the title or abstract was relevant to the topic; and (2) the article reported an *in vivo* trial. Two authors (SD and JR) independently and in duplicate screened the title and abstract of records retrieved by the search, then screened the selected full-text reports. Any disagreements were resolved by discussion. They independently and in duplicate recorded the following data: tested device (s), standard of reference, inclusion and exclusion criteria; study population at a patient and a tooth levels; observers.

Analysis

Any meta-analysis was performed due to the difference of the protocols; study characteristics and results were described qualitatively.

RESULTS

Results of the Search

The results of the search are presented in Table 1. Of the 11 articles originally identified with the search keyword,[13-23] only three articles met all the inclusion criteria and were retained for this review.[14-16]

Included Studies

The three articles included in the present review were related to three different *in vivo* studies..[14-16] The protocol details for the three included studies are given in Table 2. Two surveys were undertaken only on permanent teeth[14,15] and one took also primary teeth into account.[16] All the three included surveys used the ICDAS-II criteria[17-19] as reference for the assessment of tested devices which were the SoproLife®,[15] SoproLife® compared to DIAGNOdent® and Spectra Caries Detection Aid®[14] or to DIAGNOdent pen®.[16] The ICDAS-II scoring

Table 1: Results of the search

	References
Included articles	• Rechmann et al[14]
	• Zeitouny et al[15]
	• Theocharopoulou et al[16]
Excluded articles	*In vitro* study – detection
	• Gomez et al[17]
	In vitro studies – basic knowledge
	• Panayotov et al[18]
	• Salehi et al[19]
	General reviews
	• Gugnani et al[20]
	• Tassery et al[21]
	Case report
	• Erol et al[22]
	LIFEDT® concept
	• Terrer et al[13]
	Out of topic
	• Rechmann et al[23]

Table 2: Protocol details of included *in vivo* studies

	Rechmann et al[14]	*Zeitouny et al*[15]	*Theocharopoulou et al*[16]
Tested device(s)	• SoproLife® • DIAGNOdent® • Spectra Caries Detection Aid®	• SoproLife®	• SoproLife® • DIAGNOdent pen®
Reference standard	• ICDAS (cut-off value 3) *In vivo* • Bitewing digital radiographs	• ICDAS (cut-off value 1) *In vivo*	• ICDAS (cut-off value 3) *Ex vivo*: on pictures taken with SoproLife® in daylight mode
Inclusion criteria	• Patients aged 13 years or older • Patients with no occlusal restorations/ sealants on at least one molar or premolar • Patients with at least one untreated molar or premolar occlusal surface presenting a 0-5 ICDAS II score	• Patients 15–65 years old • Patients with fully unrestored dental arches	• Patients aged 3–12 years old
Exclusion criteria	• Patients suffering from systemic diseases, with a significant past or medical history with conditions that may affect oral health (i.e., diabetes, HIV, heart conditions that require antibiotic prophylaxis), or were taking medications that may affect the oral flora (e.g., antibiotic use in the past 3 months)	• Patients with posterior restorations • Patients with poor oral health (chronic or acute infection) • Patients with conditions that may affect oral health or oral flora (i.e., diabetes, HIV, and heart conditions which require antibiotic prophylaxis) or taking medication that may affect the oral flora or salivary flow; • Pregnant or breastfeeding women	• Uncooperative or anxious children • Patients with temporary molar hypomineralisation or MIH • Patients with hypoplastic pits, sound restorations and frank occlusal cavitation
Effective sample size calculation	Not specify	Not specify	Not specify
Patients	100 patients Mean age: 23.4 ± 10.6 years Age range: 13–58.3 years	21 patients Mean age: 30.61 years Age range: 15–65 years	20 patients Mean age: Not specify Age range: 3–12 years old
Occlusal surfaces and teeth	433 occlusal surfaces: • 90 on premolars • 343 on molars On each tooth, up to five fissure areas were separately evaluated per tooth	219 occlusal surfaces: • 121 on premolars • 98 on molars	37 occlusal surfaces: • 13 on primary molars • 24 on permanent molars
Observers	Two examiners • No specification about calibration prior study BUT • Blinded to each other's evaluation results • After independently scoring for ICDAS-II, finding discussion and agreement on one ICDAS-II score	Two independent calibrated dentists	Five examiners for the ICDAS-II on pictures who had a short online training on the ICDAS website and the SoproLife® using detection mode No information for the SoproLife® and DIAGNOdent pen® use

MIH: Molar incisor hypomineralization

was done *in vivo* in Rechmann et al[14] and Zeitouny et al[15] surveys when Theocharopoulou et al[16] used pictures taken with SoproLife® in daylight mode for an *ex vivo* scoring.

Table 3 presents the values of the validity-related parameters reported in the three included articles.[14-16]

DISCUSSION

The present review aims to report the *in vivo* scientific evidence regarding the validity of the SoproLife® camera in terms of detection of occlusal carious lesions. It did not search other databases, such as LILACS and SciELO, which include publications in Portuguese and Spanish, or other language medical databases. It did not attempt to review aspects, such as operator and patient satisfaction neither with the technique nor with the cost effectiveness in relation to other approaches.

Only three surveys came out from the electronic search on PubMed. The major limitation of this paper is the small number of included studies due to the fact that

Table 3: Results of included studies in terms of validity parameters

	Rechmann et al[14]	*Zeitouny et al*[15]	*Theocharopoulou et al*[16]
Sensitivity	• SoproLife®* daylight mode: 0.93 (95%CI: 0.88–0.96) • SoproLife®* detection mode: 0.95 (95%CI: 0.91–0.98) • Spectra Caries Detection Aid®: 0.92 (95%CI: 0.87–0.96) • DIAGNOdent®: 0.87 (95%CI: 0.81–0.92)	• SoproLife® detection mode: 0.93	• SoproLife® detection mode: 0.43 (95%CI: 0.23–0.66) • DIAGNOdent pen®: 0.62 (95%CI: 0.39–0.81)
Specificity	• SoproLife®* daylight: 0.63 (95%CI: 0.59–0.66) • SoproLife®* detection mode: 0.55 (95%CI: 0.52–0.59) • Spectra Caries Detection Aid®: 0.37 (95%CI: 0.34–0.40) • DIAGNOdent®: 0.66 (95%CI: 0.63–0.69)	• SoproLife® detection mode: 0.88	• SoproLife® detection mode: 1 (95%CI: 0.76–1) • DIAGNOdent pen®: 0.81 (95%CI: 0.54–0.95)
Area under the ROC	• SoproLife®* daylight mode: 0.88 (95%CI: 0.85–0.91) • SoproLife®* detection mode: 0.89 (95%CI: 0.86–0.91) • DIAGNOdent®: 0.87 (95%CI: 0.84–0.90) • Spectra Caries Detection Aid®: 0.82 (95%CI: 0.78–0.86)	Not specify	Not specify
Interobserver reproducibility	Not specify	• ICDAS-II: 0.97 (95%CI: 0.96–0.98) • SoproLife® detection mode: 0.98 (95%CI: 0.97–0.98)	• ICDAS-II: 0.70 (95%CI: 0.51–0.83) • SoproLife® detection mode: 0.72 (95%CI: 0.55–0.84) • DIAGNOdent pen®: not specify
Intraobserver reproducibility	Not specify	Not specify	Not specify

ICDAS: International Caries Detection and Assessment System; 95%CI: 95% confidence interval; Sensitivity: Ability to detect carious lesions (in order to avoid false negatives); Specificity: Ability to detect noncarious lesions (in order to avoid false positives); Interobserver reproducibility *: The variation arising using the same measurement process among operators; Intraobserver reproducibility *: The variation arising using the same measurement process for each operator over time period; *: Interpretation of the reproducibility values: 0.0–0.2: Slight agreement; 0.21–0.4: Fair agreement; 0.41–0.6: Moderate agreement; 0.61–0.8: Substantial agreement; 0.81–1: Almost perfect agreement; ROC: Receiver operating characteristic. The area under the ROC curve illustrates the proportion of the true positives against the proportion of the false positive; thus it illustrates the overall accuracy of a test, namely ability to discriminate between "carious" and "noncarious"; the area under the ROC curve of a perfect test is 1.0 (indicating a high sensitivity and specificity)

SoproLife® has been recently developed and evaluated (first publication on PubMed in 2009).[12] None of the three studies reported a sample size calculation (neither at a patient level nor at a tooth level) and wide discrepancies exist between studies. Indeed, Rechmann et al[14] recruited 100 patients when the two other surveys included only 21[15] and 20[16] patients; 433 and 219 permanent teeth were included respectively within Rechmann et al[14] and Zeitouny et al[15] surveys when Theocharopoulou et al[16] made their assessment on only 24 permanent teeth.

The SoproLife® validity values varied markedly among studies with a SN range between 0.43[16] and 0.95[14] and a SP between 0.55[14] and 1[16] when compared to ICDAS. The wide variations might be due to the differences between the study protocols. If the gold standard was similar among the three studies, namely ICDAS scoring system which[24-26] is a widely used international system showing reproducibility, validity, and diagnostic accuracy for the detection of occlusal carious lesions at varying stages,[27,28] the methods to allocate the score were different within studies. Indeed, different ICDAS cut-off values were used between studies: namely, 3 for two studies[14,16] and 1 for one.[15] Moreover, the ICDAS scoring was performed *in vivo* (three dimensions)[14,15] or *ex vivo* on two-dimensional SoproLife® pictures.[16] Therefore, those differences did not allow a meta-analysis.

The results show a tendency for higher SN values compared to the SP values for studies involving only permanent teeth[14,15] when an opposite tendency was found in the study on both primary and permanent teeth.[16]

This might be explained by the SoproLife® characteristics themselves as the device combines a high-magnification intraoral camera and a laser fluorescence device allowing a high discrimination more particularly in anfractuous permanent premolars and molars. Rechmann et al[14] described properly the material and methods they used, when the authors of the other studies were less accurate; moreover, Rechmann et al[14] were the only ones to mention the area under the ROC curve (0.89 for the SoproLife® camera which means a high overall ability to discriminate between "carious" and "noncarious"). Furthermore, wide discrepancies can be highlighted toward other parameters of a detection tool validity criteria, such as inter- and intraobserver reproducibility. Interobserver reproducibility values of the SoproLife® camera and the ICDAS were very similar within each study but slightly different between studies (respectively 0.98 and 0.97 for Zeitouny et al[15] and 0.72 and 0.70 for Theocharopoulou et al[16]); those variations might be explained by the mode of scoring (*in vivo* or *ex vivo* as mentioned above) and the experience of the examiners. It can be noticed that none of the studies reported about intraobserver reproducibility.

The SoproLife® camera is an innovative device combining a high-magnification intraoral camera and a laser fluorescence device that may support the patient–practitioner communication. Moreover, free of ionizing radiation, SoproLife® device could be useful in the carious lesion detection in children and pregnant women. The present review, the first on the topic, shows wide discrepancies toward SoproLife® camera validity parameters for the detection of occlusal carious lesions. No clear-cut conclusion can be made based on the three included studies. Zeitouny et al[15] underlined that financially ICDAS is better than SoproLife®. Further high-quality *in vivo* investigations are needed to confirm the validity of the SoproLife® camera in terms of occlusal caries detection.

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