ANALYSIS OF UniViSS CLINICAL PERFORMANCE IN OCCLUSAL CARIES DETECTION

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ABSTRACT

There is a large number of visual systems for describing carious process propagation on dental surfaces. Despite numerous advantages, all these systems show some deficiencies. Wishing to overcome the deficiencies of visual systems for the detection and description of caries, a group of authors created Universal Visual Scoring System (UniViSS). This system is designed to compensate for the disadvantages of existing visual diagnostic systems, to meet the contemporary requirements set for caries detection / diagnosis and to be flexible.

The aim of this study was to evaluate diagnostic performances of UniViSS on occlusal surfaces in clinical conditions, through sensitivity, specificity, positive and negative predictive values.

Material and methods: Study sample consisted of 140 permanent molars with established occlusal caries lesion. During clinical examination, each lesion was classified according to UniViSS criteria, and laser fluorescence and digital radiography examination were performed. For ethical reasons, if two of three diagnostic methods confirmed existence of caries lesion, cavity was opened, as validation method. The depth of the lesion propagation was recorded using World Health Organization's graduated probe, as the distance between the deepest point of the cavity and enamel surface.

Results of study are presented tabularly and compared to similar investigations through comparing sensitivity, specificity, positive and negative predictive values of registered UniViss scores.

Key words: occlusal caries detection, occlusal caries diagnosis, UniViSS.

Introduction

Diagnosis is a clinical procedure preceding a decision on treatment. Caries diagnosis implies detection of a carious lesion, determination of its depth and degree of demineralization followed by decision making regarding its activity. It can be seen as a procedure that involves three steps - identification/detection of the lesion, assessment of the severity of the lesion and assessment of its activity. Active lesions require active treatment. It implies preventive, non-operative, but also operative treatment in order to restore the integrity of the dental surface in a way of anabling patient to clean those surfaces [1, 2].

An ideal diagnostic method should be safe for both the patient and the therapist and enable the detection of the lesion at an early stage. It should also be objective and quantitative, non-invasive and inexpensive [3].

Visual-tactile examination is the basis for the identification of carious lesions that require biologically based treatment demanding an assessment of lesion activity and surface integrity. Each surface of each tooth in the dental arch is examined using a standardized sequence of procedures that establish the existence of deviations from the average regularity, in terms of changes in color, luster, texture of the surface of the dental crown and surface integrity. The process of carious lesion detection involves distinguishing lesions with cavitation, active lesions without cavitation and stopped lesions (with or without cavitation), in relation to the average regular appearance of the surface of the tooth crown [4].

Visual inspection is widely used in clinical practice for the detection of carious lesions on the occlusal surfaces of teeth [5]]. A clinical examination with the use of a dental mirror and probe is usually used for the diagnosis of caries. However, the value of probing has been criticized as it does not improve diagnostic accuracy. Due to the variation in the morphology of the fissure system, the sharpness of the probe and the pressure produced by the examiner, can give different results. The use of a dental probe in the area of white spot or cloudy enamel can lead to irreversible damage in the area of occlusal fissures, leading to irreversible enamel defects in demineralized occlusal fissures by converting subsurface lesions into cavitations. The probe also enables the transmission of cariogenic bacteria from one infected site to another, damages the integrity of the fissure, facilitates the progression of the lesion and may be less accurate in establishing a diagnosis than the visual examination itself. [6, 7, 8, 9, 10].

Ekstrand et al. (in papers published in 1997, 1998, 2001), and Ricketts et al. (in a paper published in 2002) created and evaluated a scoring system for the detection of occlusal lesions, prediction of their depth, assessment of activity and prediction of whether the lesion is infected. Nyvad et al (in a paper published in 1999) developed a system for the diagnosis of caries which differentiates early carious lesions from lesions with cavitation being able to differentiate ten scores/values in suboptimal clinical conditions. However, this system was not exclusively visual, but visual-tactile, because a dental probe was used to determine the characteristics of the surface of the examined lesion as smooth, rough or with fractures. Fyffe et al created a visual caries diagnosis system based on diagnostic thresholds: D1 (enamel and dentin, including initial lesions), D2 (enamel and dentin, but excluding initial lesions), and D3 (dentin). The system describes eight categories of lesions to which the appropriate codes are assigned [11, 12].

The visual appearance of the initial carious lesions is described and evaluated in numerous studies using the International Caries Detection and Assessment System (ICDAS) [13]. It is designed to detect six stages of the carious process, ranging from early clinically visible changes in enamel caused by demineralization to extensive cavitation. The system is divided into sections including coronary caries (caries of fissures and pits, mesial/distal and buccal/oral surfaces), root caries and caries associated with restorations and fissure sealants.

In 2021, Bulbuk et al. [14] presented the LOV/DD cavity classification. The classification includes two divisions of cavities. The first division was made according to the Depth of Destruction (DD), and divides cavities into 5 categories (0 – 4). The second division of cavities divides according to Localization of the defect, Occlusal load and Volume of the defect (LOV), and according to it, all cavities are divided into four groups.

The diagnostic systems of Ekstrand et al., Nyvad et al., and the ICDAS working group included carious lesions without cavitation, but classified carious lesions only on the basis of several criteria. Due to the fact that the clinical appearance of a carious lesion is complex, it is likely that a limited set of criteria will not be able to describe the clinical appearance of the lesion accurately enough. The ICDAS criteria, for example, do not distinguish between white and brown discolorations of a carious lesion, which, in fact, provide important information about the activity of the lesion. Classification of lesions characterized by both white opacities and brown discolorations is difficult as precise differentiation of brown discolorations and microcavitations. Such clinical experiences, as well as the fact that some auxiliary diagnostic methods (eg laser fluorescence, or qualitative light-induced fluorescence) did not give satisfactory results in the diagnosis of lesions without cavitation, were the main impetus for the development of the Universal Visual Scoring System (UniViSS) for lesions on occlusal and smooth surfaces. This system is designed to compensate for the shortcomings of existing visual diagnostic systems, to meet the modern requirements for caries detection/diagnosis methods, as well as to be adaptable. System can be used without restrictions in patients of all age groups, in the conditions of field, clinical and laboratory research [15, 16].

UniViSS uses a three-step diagnostic procedure for a detailed classification of the complex clinical appearance of the caries lesion:

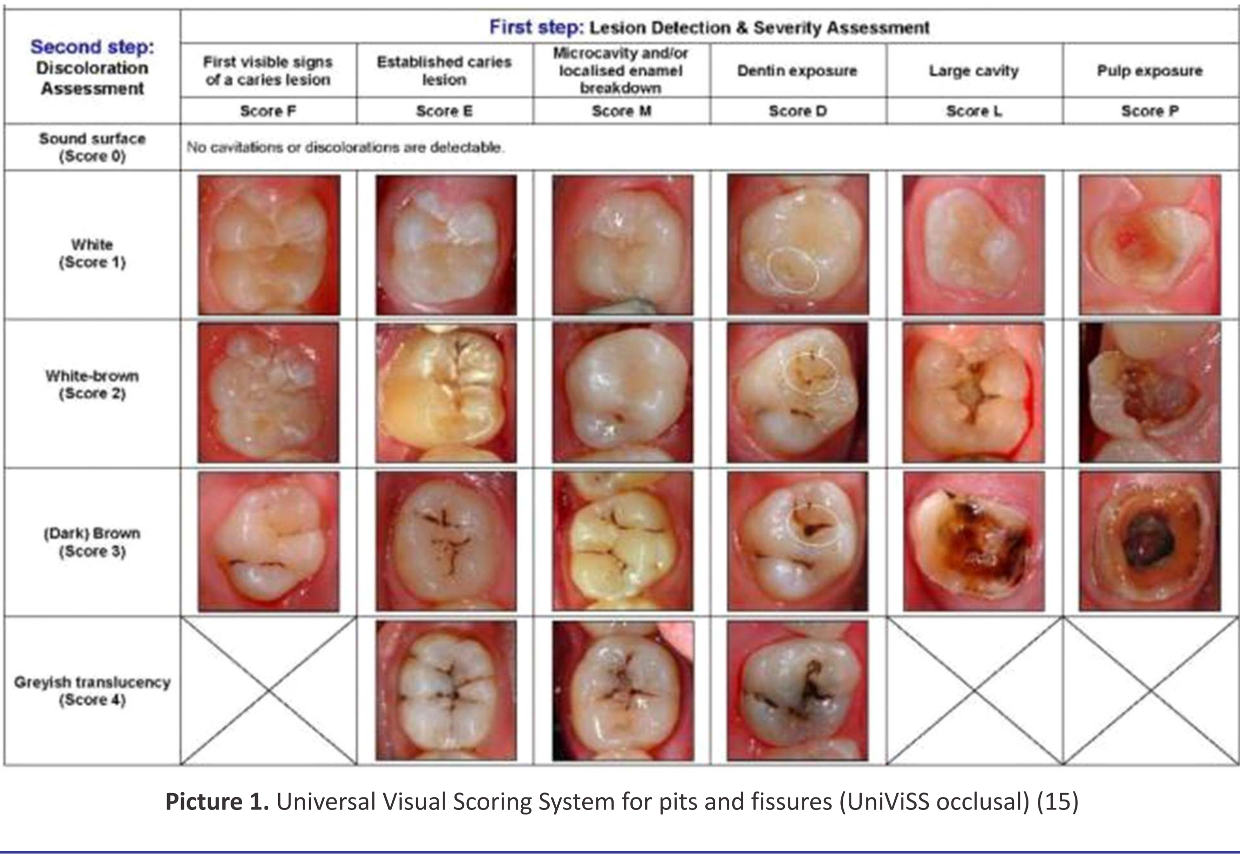
1. assess the severity of the lesion
2. estimate discoloration
3. assessment of the activity.

The standard equipment required for the examination consists of a CPI probe and a dental mirror. The CPI probe is used as an auxiliary instrument in the metric differentiation between established lesions and microcavitations, as well as for tactile examination of dental surfaces without pressure [15].

Material and methods

The study sample consisted of 140 permanent molars. Each of the tooth involved in the study had to have occlusal surface meeting the following criteria:

1. Patient older than 16 years, considering post eruptive maturation of enamel.
2. Occlusal fissure system with visible discoloured brown or black area without cavitation.



Picture 1. Universal Visual Scoring System for pits and fissures (UniViSS occlusal) (15)

3. Gray discoloration derived from carious dentine underneath the non-cavitated enamel.

4. Obvious occlusal cavitation.

The appearance of the fissure system on the occlusal surface is classified according to the UniViSS scoring system (Picture 1.). All teeth were also examined using laser fluorescence (DIAGNOdent 2095, KaVo, Biberach, Germany), and digital radiography (De Götzen xgenus® digital device, De Götzen S. r. l. Via Roma, 45-21057 Olgate Olona (VA)-Italy, software version 1.30.113). Validation of the collected data was performed by cavity opening. For ethical reasons, the decision on operative treatment was made if the results of two diagnostic methods were in favour of the presence of caries in the vicinity of the enamel-dentinal border, or dentinal caries. The depth of the lesion propagation was recorded using World Health Organization's graduated probe, as the distance between the deepest point of the cavity and enamel surface. Diagnostic procedure is described in details in previously published papers of the same group of authors [17, 18, 19].

Results

For the purposes of statistical analysis, UniViSS scores were transformed into ordinal values:

0 – no caries

1 – opacity or barely visible discoloration on a wet surface, but clearly visible after air drying, the probe does not stick (F1, F2, F3)

2 - opacity or clearly visible discolouration and without drying, the probe gets stuck (E1, E2, E3, E4)

3 - localized enamel defect on discolored enamel and/or visible presence of discolored dentin through the enamel (M1, M2, M3, M4)

4 - cavity with exposed dentin (D1, D2, D3, D4, L1, L2, L3, P1, P2, P3).

Score values 1 and 2 were considered to represent caries in enamel, and values 3 and 4 were considered to represent caries in dentin.

The results are presented in Tables 1, 2, and 3.

		UniViSS				
		1 – opacity/ discoloration visible after drying	2 – opacity/ discoloration visible without drying	3 – localised enamel defect /microcavity	4 – dentine exposure	Total
Validation method	0 – no caries	3	0	0	0	3
	1 - enamel caries	11	6	0	2	19
	2 - caries in the outer half of dentin	20	35	18	25	98
	3 - caries affects more than half of dentinal depth	2	2	6	10	20
	Total	36	43	24	37	140

Table 1. Cross-tabulation of UNIViSS and validation method

			UniViSS	Diagno Dent	RVG	Validation method
Spearman's rho	UniViSS	Correlation Coefficient	1,000	,242(**)	,150	,409(**)
		Sig. (2-tailed)	.	,004	,077	,000
		N	140	140	140	140
	Diagno Dent	Correlation Coefficient	,242(**)	1,000	,200(**)	,277(**)
		Sig. (2-tailed)	,004	.	,018	,001
		N	140	140	140	140
	RVG	Correlation Coefficient	,150	,200	1,000	,457
		Sig. (2-tailed)	,077	,018	.	,000
		N	140	140	140	140
	Validation method	Correlation Coefficient	,409(**)	,277(**)	,457(**)	1,000
		Sig. (2-tailed)	,000	,001	,000	.
		N	140	140	140	140

12. Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed)

Table 2. Spearman's correlation coefficient

	D2				
	SE (95% CI)	**SP** (95% CI)	**PPv** (95% CI)	**NPV** (95% CI)	**AUC** (95% CI)
UniViSS	**0.42** (0.20 – 0.67)	**1.00** (0.31 – 1.00)	**1.00** (0.63 – 1.00)	**0.21** (0.05 – 0.51)	**0.711** (0.480 – 0.881)
	D3				
	SE (95% CI)	**SP** (95% CI)	**PPv** (95% CI)	**NPV** (95% CI)	**AUC** (95% CI)
UniViSS	**0.80** (0.70 – 0.87)	**0.64** (0.41 – 0.83)	**0.91** (0.83 – 0.96)	**0.41** (0.25 – 0.59)	**0.751** (0.664 – 0.826)

Table 3. Sensitivity values (SE), specificity values (SP), positive predictive values (PPV), negative predictive values (NPV) and values under ROC curve (AUC) for UniViSS

Discussion

Diagnostics of occlusal caries has become a big challenge for dental practitioners in recent years, due to the significant decrease in the prevalence of caries worldwide. The reason for this is a decrease in the incidence of deep dentine caries and an increase in the incidence of superficial caries of occlusal surfaces. The occlusal surfaces of the crowns are the surfaces most susceptible to caries in children, adolescents and adults. Caries diagnostics can be complicated by the possibility that occlusal caries of dentin occurs under the macroscopically intact surface of the enamel thus making diagnosis by conventional methods difficult. Conventional diagnostic procedure is based on a visual-tactile examination. The sensitivity of the visual-tactile examination does not meet the requirements of modern dentistry. False negative results of this diagnostic procedure can be a consequence of the morphology of the fissure system on the occlusal surface, but also of intense fluoridation. Initial lesions in fissures and pits of the occlusal surface often go undiagnosed because they start on their walls and are difficult to detect. That is why it is recommended to combine a visual or visual-tactile examination which is characterized by high specificity, but insufficient sensitivity, with one of the diagnostic methods characterized by high sensitivity. An ideal diagnostic method should be characterized by high sensitivity and high specificity [20, 21, 22].

Nelson et al. [23] point out that there is still no standard system for caries detection and evaluation that is universally accepted among researchers. There are several caries detection systems in use attempting to describe and diagnose the caries process. The evidence points to the poor results of these methods, considering the large number of false negative diagnoses in the case of the presence of a carious lesion, and the low to moderate number of false positive diagnoses in the absence of a carious lesion. During 2004, a total of 29 visual and visual-tactile caries detection methods that were in use from 1950 to 2000 were analyzed, and not a single method reached the desired validity standards. This lack of consistency in the detection, reporting, description and interpretation of caries among the mentioned systems limits the possibility of comparing the results of clinical studies.

Agnes et al. [24] state that visual inspection was considered an invaluable diagnostic tool during the past decades. Due to the high specificity values, it made possible to avoid unnecessary treatments, mainly in populations with a low caries prevalence. Recently, visual inspection has also shown low sensitivity values which is significant in order to prevent non-treatment. These authors believe that the aforementioned is a consequence of the introduction into practice of the visual diagnostic system of Ekstrand and associates.

The results of the research by Künisch et al. [10] support the view that visual inspection of a clean and dry occlusal surface is the method of first choice in everyday practice, but that the sharp probe should be replaced by a CPI probe with a spherical tip.

Künisch et al [15, 24] evaluated UniViSS performance on extracted third molars with histological validation. For enamel caries, recorded values of sensitivity and specificity were 1.00 and 0.58. For dentinal caries detection, sensitivity value was 0.63 and specificity 0.98. Taking into account the suggestion that the sum of sensitivity and specificity values should be approximately 1.6 in order for the diagnostic method to be considered a legitimate candidate for practical use, these values illustrate the potential of UniViSS. Considering the reproducibility UniViSS, the authors believe that the UniViSS score for discoloration is more difficult to reproduce in relation to the scores ICDAS II. In our sample, at diagnostic threshold D2, the sensitivity and specificity sum were 1.42 (SE = 0.42, SP = 1.00) and at diagnostic threshold D3 - 1.44 (SE = 0.80, SP = 0.64). These differences can be explained by the fact that this research was in vivo and that detailed histological evaluation of recorded scores was not possible for ethical reasons. The recorded results, regardless of the above-mentioned differences, are comparable to the results of Künisch and associates.

In an in vivo study of the effectiveness of diagnosing minimal carious lesions using a visual-tactile examination (according to the criteria of Ekstrand et al.), laser fluorescence, and histological validation as the gold standard, Živojinović and Marković [20] recorded a sensitivity value of 0.36 and a specificity of 0.83, for the visual-tactile examination. The sample in this study consisted of 120 teeth of the transcanine sector that were determined for extraction for orthodontic, prosthetic or surgical reasons, and therefore histological validation of the results was possible. It was shown, based on the visual-tactile examination, that the correct therapeutic decision was made in 55% of cases. The authors point out that neither visual-tactile examination nor laser fluorescence are absolutely effective in diagnosing early carious lesions on occlusal surfaces.

Zaidi et al. [25] evaluated in vivo the effectiveness of laser fluorescence in the detection of occlusal caries compared to visual inspection and the use of an intraoral camera. For enamel caries, the sensitivity of the visual examination (Ekstrand criteria) was 0.65. For caries in dentin, the sensitivity of the visual examination was 0.57.

Künisch et al. [26] examined the detection of occlusal caries on permanent molars using the WHO basic method, ICDAS and laser fluorescence. In their research, 27.1% of fissures and 53.9% of pits were diagnosed as healthy using ICDAS and laser fluorescence. A noticeable difference occurred in obvious carious lesions needed restoration (ICDAS score ⩾ 4, DIAGNOdent value >31). Both methods classified 5.2% of occlusal fissures and 3.4% pits in this category, 22.7% of fissures and 10.4% pits were assigned a lower ICDAS score (DIAGNOdent >31, ICDAS<4). Only 0.9% of fissures and 0.1% of pits were not in accordance with the expected DIAGNOdent values (DIAGNOdent <31, ICDAS ⩾ 4). These facts once again highlight the difficulty in accurately diagnosing carious lesions without cavitation.

Dičak et al. [21] found that visual-tactile diagnostics and diagnostics with DIAGNOdent in 90.5% of cases showed a coincidence of no caries presence, in a research comparing the visual-tactile detection of caries and the application of laser fluorescence in 30 subjects on 960 teeth of the transcanine sector. In 5.94% of cases it is shown that caries exist. The ratio of actual agreement was 96.46%. The rate of coincidence was 85.73%. Absolute disagreement was recorded in 3.54% of cases.

Jablonski-Momeni et al. [27] also evaluated in vitro the use of ICDAS, laser fluorescence, fluorescence camera and digital retrocoronary radiography in the detection of occlusal caries. The validation method was cavity opening. For enamel caries (D1), sensitivity and specificity values for ICDAS were 1.00. For caries in dentin (D3), the sensitivity value for ICDAS was 0.70 and the specificity was 0.95. AUC value for ICDAS was 0.92. Spearman's correlation coefficient between all methods showed that all correlations were significant, both at the confidence level of 0.01 and 0.05. A strong positive correlation was found between ICDAS and the gold standard.

Conclusion

UniViSS is applicable in clinical practice, but considering the fact that ICDAS is more used in investigations and clinical research, we recommend more intensive promotion of UniViSS use in those conditions.

Declaration of interest

There is not any conflict of interest for this material in the manuscript for all authors, between the authors, or for any organization.

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