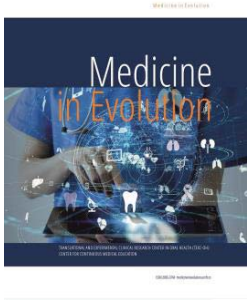
New methods in cavity detection



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Abstract

Introduction: Currently, there is significant interest in the early detection and treatment of cavities. Dental caries, the primary cause of tooth decay, ranks among the most prevalent chronic oral diseases globally. Caries develops due to multiple cycles of demineralization and remineralization, which are natural processes occurring within the oral cavity.

Aim of the Study: The present study aims to observe the effectiveness of the Vista Cam IX device (Durr Dental, Bietigheim-Bissingen, Germany) in detecting incipient caries on the occlusal surfaces of posterior teeth and in the non-invasive conservative treatment of non-cavitated on posterior teeth.

Material and Methods: For this study, 5 clinical cases (young adults aged 18-30 years) were examined using intraoral images and the fluorescent camera Vista Cam iX. Inclusion criteria were 5 first lower molars with occlusal carious lesions coded 1, 2, and 3 according to the ICDAS-II classification. Exclusion criteria were surfaces with restorations, extensive lesions, or enamel defects. Before commencing the procedure, the dentist underwent training according to the manufacturer's specifications. Measurements using the Vista Cam iX were performed at the tooth level, with isolation and drying using cotton rolls. The measured values, ranging from 0-3, corresponded to the severity of the lesion. Measurements were repeated on the same teeth one year after completion of non-invasive treatment.

Results and Discussions: Out of the total number of surfaces examined, 60% were male patients and 40% were female, all of whom presented carious lesions in pits and fissures with an ICDAS-II score ranging from 1-3. Upon reevaluation after 1 year, 22 carious sites were detected. According to the results of this study, it can be stated that the Vista Cam iX, alongside the intraoral camera with high magnification, demonstrated a good ability to detect even the smallest lesions in pits and fissures. For one year, only preventive treatments were performed,

and upon evaluation after one year, no progression of caries depth was observed in patients who adhered to oral hygiene recommendations. However, for those who did not follow the recommendations, an increase in lesion diameter was observed.

Conclusions: The present study concludes that a combination of various detection methods, including the ICDAS-II classification, the intraoral camera with high magnification, and the fluorescent camera Vista Cam iX, is the key to achieving increased clinical efficiency and providing clinicians with precise data about the current status of the lesion. This aids in selecting the ideal treatment for the case

Keywords: cavity detection, fluorescence camera, non-invasive treatment, occlusal pit and fissutr caries, incipient non-cavitated carious lesion

INTRODUCTION

Dental decay is among the most prevalent chronic diseases globally, affecting 60-90% of the world's population. Dental caries is a microbial infection of the teeth, leading to localized dissolution and destruction of the calcified tissues. The formation of cavities in the teeth, characterized by the destruction of the tooth surface and the creation of cavities or defects, indicates bacterial infection. [1]

The activity of caries, demonstrated by demineralization and loss of tooth structure, varies significantly, making the progression of individual lesions unpredictable at times. Caries lesions develop only in the presence of a large mass of bacteria capable of creating an acidic environment sufficient to demineralize tooth structure. Plaque bacteria metabolize refined carbohydrates to produce energy and organic acids as a result. These acids can lead to the formation of carious lesions by dissolving the crystalline structure of the tooth. [2][3]

The primary group of bacteria responsible for dental caries is Streptococcus mutans, which comprises eight serotypes: Streptococcus Rattus, Streptococcus cricetus, Streptococcus ferrous, and Streptococcus sobrinus. While all serotypes of S. mutans demonstrate significant potential to cause caries, their considerable genetic and biochemical distinctions mean they should not be considered a single species of S. mutans. Both Streptococcus mutans and lactobacilli produce a substantial amount of acids (acidogenic) and are tolerant to acidic environments (aciduric). They are stimulated by sucrose and are considered primary organisms associated with caries in humans. [4]

Identifying carious lesions that necessitate restoration is challenging. No single traditional diagnostic method can reliably detect pre-cavitated carious lesions on all tooth surfaces. Cavitation of the tooth surface represents a late stage in the carious process. [5][6]

Typically, to diagnose caries more accurately, it's advisable to conduct multiple tests. Relying solely on an explorer is unreliable due to potential mechanical binding caused by factors unrelated to caries presence. Similarly, using only radiographs can be unreliable due to technical challenges like exposure, angulation, tooth positioning, presence of restorations, and interpretation biases. Furthermore, demineralization visible on radiographs doesn't always indicate active caries. [7][8]

Detecting caries in pits and fissures poses a challenge because it's often difficult to differentiate them from the standard anatomical features of these structures. While cavitation at the base of a pit or fissure can sometimes be detected using an explorer tip, mechanical binding of the explorer may occur due to non-carious factors such as the shape of the fissure, sharpness of the explorer, or force of application. Thus, relying solely on an explorer is insufficient for caries diagnosis. Discoloration limited to the depth of pits and grooves can also be present in healthy teeth, leading to potential misdiagnosis of carious lesions. [9]

To address these challenges, the U.S. Public Health Service developed additional criteria for diagnosing caries in pits and fissures. These include softening at the base of the pit or fissure, opacity surrounding the pit or fissure indicating enamel undermining or demineralization, and softened enamel that may flake away upon exploration. (Table 1) [10] [11]

Table 1. Clinical enamel status and different appearance of it under different environment and affective conditions

Clinical enamel status	Wet	Dry	Surface texture
1) Normal enamel	translucent	translucent	smooth
2) Hypocalcified enamel	opaque	opaque	rough
3) Incipient caries	translucent	opaque	rough
4) Active caries	opaque	opaque	rough
5) Arrested caries	dark opaque	dark opaque	rough

Aim and objectives

To assess the effectiveness of modern digital devices like the Vista Cam iX (Durr Dental, Bietigheim-Bissingen, Germany) in accurately detecting early occlusal caries on posterior teeth and providing non-invasive conservative treatment for non-cavitated posterior teeth.

MATERIAL AND METHODS

All patients provided informed consent before participating in the clinical study. A prospective examination of five clinical cases was conducted during this research, utilizing intraoral images and the fluorescence camera of the Vista Cam iX device (Durr Dental, Bietigheim-Bissingen, Germany). The inclusion criteria for this study comprised five permanent lower first molars of young adults aged 18-30 years with ICDAS-II occlusal lesion codes 1, 2, and 3. Dental surfaces with visible restorations, extensive cavities, enamel defects such as hypomineralization or hypoplasia, extrinsic or intrinsic enamel staining, or deep cavitated dentin caries with loss of the wall were excluded from the analysis.

During this study, the Vista Cam iX (Durr Dental, Bietigheim-Bissingen, Germany), an intraoral self-calibrating fluorescence camera, was utilized. Two interchangeable heads of this device were employed. The "Proof" interchangeable head was connected to a laptop equipped with special software (DBSWIN, Durr) for analyzing acquired images. This head emits high-energy blue-violet light at 405 nm onto the occlusal tooth area. The violet light emitted by this device excites metabolites of cariogenic bacteria, causing them to fluoresce in red, contrasting with sound enamel, which appears green. Carious tissue and healthy tissue emit fluorescence at different intensities when stimulated by light at specific wavelengths. Digital images display lesions in various color shades, accompanied by a numerical score ranging from 0 to 3, indicating the extent and depth of occlusal caries. This aids in identifying "hidden caries" and enables the easy detection of occlusal dentin caries lesions beneath clinically intact tooth surfaces in both permanent and deciduous teeth.

Before taking intraoral pictures and commencing operative measurements with the Vista "Proof," the teeth were cleaned and dried. Measurements with the Vista Cam iX (Durr Dental, Bietigheim-Bissingen, Germany) were conducted under cotton roll isolation and drying of the tooth with air to ensure clearer results. The measured values, ranging from 0 to 3, correspond to the severity of the lesion and represent the intensity of red and green fluorescence (Table 2).

Table 2. Classification of fluorescence images, obtained by Vista Proof, according to the depth of the carious lesion

Color	Classification according to manufacturer	Lesion depth (mm)	Score	Final classification
Green	Healthy enamel	<1	0	Absence of caries
Purple	Initial enamel caries	<1 to <1.5	1	Presence of caries
Red	Caries in DEJ	<1.5 to <2	2	Presence of caries
Orange	Caries in dentin	<2 to <2.5	3	Presence of caries
Yellow	Deep caries in dentin	>2.5	4	Presence of caries

After one year of conservative non-invasive treatment, the same patients and teeth were recalled for reevaluation using the Vista Cam iX (Durr Dental, Bietigheim-Bissingen, Germany) to assess the outcomes

RESULTS

The total number of analyzed teeth was five, comprising lower jaw first molars from different patients aged 20-30 years.

Of these, 60% were male patients and 40% were female patients, all exhibiting untreated pits and fissures caries with ICDAS scores ranging from 1 to 3. Distinctive software (DBSWIN, Durr) indicated a range from 1.2 to 1.9 on the manufacturer's scale.

These patients were followed up for 12 months to monitor the progression of cavitation with non-invasive treatment. A total of 22 caries sites were identified according to the (DBSWIN, Durr) software.

DISCUSSIONS

Based on the findings of this study, the Vista Cam iX "Proof" fluorescence camera and high-magnification intraoral camera demonstrated excellent sensitivity in detecting even the smallest enamel lesions in pit and fissures. Over the one-year follow-up period, traditional invasive treatments were avoided, with only observational and preventive approaches implemented. All cases showed positive outcomes, with no progression of lesions to deeper levels on the surface. However, patients who did not adhere to home care recommendations exhibited slight enlargement of the most profound lesions in diameter.

The study effectively demonstrated that regular dental visits every six months for professional hygiene, coupled with consistent oral care at home, reduced the progression of deep cavities in existing lesions. The Vista Cam iX proved to be a valuable tool for monitoring and documenting the results obtained during the follow-up period, allowing for observation of disease progression.

Ensuring good reproducibility of the results obtained is a crucial step, as lack of reproducibility can lead to inaccuracies in treatment plans and interventions. Calibration is therefore essential in clinical research, as well as among supervisors who assist dental students in their training.

Traditional techniques like visual inspection, with or without probing, often fail to provide a precise diagnosis distinguishing between a carious lesion and mere enamel discoloration. Bitewing radiography reveals only larger lesions extending beyond the dentinoenamel junction (DEJ), while smaller enamel lesions remain obscured due to the superimposition of dental structures, resulting in increased opacity on the image.

For obtaining accurate images with the Vista Cam iX "Proof" fluorescence camera, it is essential to perform professional dental cleaning beforehand to eliminate all plaque and calculus from the tooth surface. Subsequently, the tooth should be dried and isolated from blood and saliva to mitigate sensitivity to biological substances when using the fluorescence camera.

In this study, the Vista Cam iX "Proof" camera demonstrated high sensitivity in detecting occlusal caries lesions, indicating its strong capability in identifying such lesions when present. However, this method exhibited lower specificity compared to intraoral high magnification imaging and the ICDAS, suggesting that the fluorescence camera tends to produce more false-positive results. This could lead to overtreatment, involving clinical interventions on healthy teeth. Therefore, it is advisable to monitor small enamel lesions periodically, every 6 to 12 months, using a combination of these three methods.

Previous studies have demonstrated a favorable balance between sensitivity and specificity for both the Vista Cam digital intraoral camera and visual inspection using the ICDAS criterion. Magnified images also enhance dentists' visual field, enabling more precise treatment planning. Among individuals with carious lesions, the highest likelihood of positive results was observed with the ICDAS method, followed by intraoral imaging and

fluorescence camera. Conversely, the probability of negative results was lowest with ICDAS, showing a 30% lower chance compared to intraoral imaging and four times less than fluorescence.

Future studies should consider incorporating a larger number of cases, encompassing both affected and non-affected sites across various tooth groups and locations, ideally conducting comprehensive mouth inspections using devices like the Vista Cam iX, DIFOTI, and QLF. Additionally, extending the follow-up period and examining different conditions such as assessing dental restorations for microleakage or the potential for secondary decay or residual carious lesions beneath restorations or existing cavities would be beneficial. These devices hold great promise for further exploration in the realms of preventive and conservative dentistry.

CONCLUSIONS

Caries prevention methods represent the most conservative and cost-effective approach to maintaining patients' teeth over an extended period. By understanding the nature of the carious process and shifting from the old view of caries as an irreversible disease requiring invasive treatment to a new perspective where caries is seen as a reversible condition involving stages of demineralization and remineralization, a new era of protection through prevention has emerged. Factors such as increasing dentist knowledge, utilizing modern diagnostic tools for early caries detection, and selecting appropriate materials or treatments that delay or prevent tooth demineralization while enhancing remineralization play crucial roles in the success of tooth prevention against carious lesions, particularly in the occlusal surfaces of pits and fissures.

The ideal cavity detection method should be capable of capturing the entire spectrum of carious lesions, from the earliest to the most advanced stages, with precision, ease of use, and applicability to all tooth surfaces. Combining different methods such as ICDAS, high-magnification intraoral cameras, and Vista Proof fluorescence cameras has demonstrated sufficient clinical efficacy. The data obtained from these combinations can aid dentists and researchers in selecting the most suitable method for detecting caries lesions on occlusal surfaces. Additionally, OCT and Vista Cam Proxi interchangeable heads are valuable tools for detecting proximal caries, while OCT is particularly useful in identifying residual dentinal caries after cavity preparation.

Minimal invasive dentistry represents a contemporary trend that prioritizes achieving optimal aesthetics while preserving healthy tissues to the maximum extent possible. In this context, the utilization of various modern diagnostic tools for accurately diagnosing incipient carious lesions holds great significance. The Vista Cam iX emerges as a valuable instrument aligning with the principles of modern dentistry, enabling precise diagnosis through its array of interchangeable heads and specialized software for data analysis and storage, facilitating subsequent follow-up. However, despite its advantages, this device does have limitations and requirements for ensuring accurate diagnosis, including considerations regarding the influence of various biological factors and the possibility of overdiagnosis.

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