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Diagnosis and Assessment of Dental Caries by Clinical Steps and Caries Detection Dye Solution

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Abstract. This research compares the effectiveness of caries reagent dye (CDD) with traditional diagnostic techniques for identifying carious dentin in deep cavities. The research, which was carried out at the clinics of Thi-Qar University/College of Dentistry, included the voluntary enrollment of 70 people with deep-rooted caries, ages 18 to 40. Every patient got standard dental care, and all patients were made aware of the goal and methodology of our study. Seventy teeth from seventy individuals with proximal or occlusal caries (one tooth from each patient) made up the final sample. Age: 18–40 years old, free of systemic illnesses. No clinical indications or symptoms of pulpal damage, and active and severe dentin caries affecting the occlusal and/or proximal surfaces of permanent molars and premolars, i.e., deep- caries with direct access and vision. Patients with pulp-related dental caries, intra- or extraoral swellings, systemic diseases, or any periapical conditions. Additionally, any main caries were not included. One tooth was chosen at random for each participant, yielding 70 teeth from patients with proximal (P) and/or occlusal (O) caries lesions. Caries reagent dye (CDD) was used to assess the same 70 teeth that had been clinically examined for the presence of caries using straightforward conventional diagnostic techniques. The operator began the drilling process after using preoperative pulp vitality checks to make sure there was no pulpal damage. Beginning with a slow-speed handpiece, a level surface was created and the dentine lesion was visible for both the occlusal (A) and proximal (B) cavities. Then, using a traditional round steel drill in a reverse-angled handpiece to lower the speed (400 rpm), the carious dentine was manually removed. A dental explorer was used to measure the dentine's hardness. This was done repeatedly until all of the teeth were checked with a dental explorer and either had a leather-like texture or made a harsh scratching sound. Several students, acting as inexperienced examiners, carried out the caries removal process in every topic. Following visual inspections, CDD was used to determine if residual caries was present or not. Uninfected dentin will not absorb much of the stain, however demineralized dentin will exhibit distinct staining patches. We determine if there is a positive or negative caries outcome after assessing the cavity using the two measures. As a result, The stain test results showed that 70 individuals were examined both before and after applying the stain, according to the statistics of paired samples. The results showed that the stain had a significant impact on the test on teeth as inexperienced evaluators, with the arithmetic mean after the stain being 0.71 and the arithmetic mean before the stain being 0.56 with a difference of 0.15. The (t) test value was 2.488. Conclusion, This study shows the importance of using the CDD for the beginner students and that it has a greater effective impact for its use in diagnosis and its impact in identifying deep caries is greater than the usual clinical diagnosis among students, and this is only at the student level, so the percentages could be different if the evaluators have more experience

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Highlights:

1. Compare CDD effectiveness vs. traditional methods for diagnosing deep caries.
2. 70 teeth analyzed; CDD enhanced inexperienced students' diagnostic accuracy.
3. CDD significantl Caries Reagent Dye, Deep Caries, Dental Diagnosis, Beginner Students, Clinical Effectivenessy improves caries detection, especially for beginner dental students.

Keywords: Caries Reagent Dye, Deep Caries, Dental Diagnosis, Beginner Students, Clinical Effectiveness

Introduction

Dental caries is a restricted, progressive, and destructive process that causes the mineral component of teeth's hard tissue to dissolve. It results from a number of misalignments between the oral environment and teeth. This imbalanced state causes the pH to drop and also causes microbial acid production (1). Dental caries develops throughout time from a physiological process to pathology, impacted by a variety of circumstances, and there is no distinct boundary between health and illness. (2). A precise diagnosis is necessary for the clinical therapy of dental caries.

Therefore, before selecting a treatment strategy that may encompass a range of therapeutic treatments, the characteristics of the patient's caries disease symptoms must be assessed. (3). The methods used by dentists to identify dental caries, determine whether to take action, and choose which treatments to suggest vary widely. A thorough assessment found that most applications lacked enough data to support generalizations about the sensitivity and specificity of six commonly used methods for detecting carious lesions. Caries diagnosis requires clear, dry teeth, sufficient lighting, and simple visual access. (4).

Visual and tactile examination, illumination, chemical analysis, radiography, and electrical conductance inspection are examples of diagnostic procedures. Before restoration can start, cavities must have all carious dentine removed.

The procedure is often regarded as complete when there are no stains and the dentine surface feels hard to the touch. It is basically a clinical choice to determine which dentine may be remineralized and which cannot. In order to be clinically useful, a caries detector dye must selectively stain diseased demineralized dentine. Caries detector dyes

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may be employed in addition to the usual criteria of tactile and visual evaluation. If it occurs, it will act as a guide to remove tissue that has been irreversibly decalcified. (5).

In 1972, a straightforward fuchsin red stain was suggested (and eventually refined) as a means of aiding in the differentiation of the two layers of carious dentin. (6) 7.

Because of its potential carcinogenicity, the basic fuchsin stain was finally replaced with the acid red solution dye. (8). Many protein dyes have since been marketed as instruments for identifying tooth cavities. The dye was intended to enhance the complete removal of sick carious dentin without unduly diminishing sound dentin, and it was promoted as a "painless" way to remove caries without the need for local anesthetic.

The staining approach was the most time-consuming part of the process since it included using a slow-speed bur and several dye application and removal repetitions.The idea of a diagnostic instrument that could differentiate between sick dentin was deemed valuable since tactile and visual criteria are usually used to proclaim a cavity caries-free. More clinical studies were carried out in the United States. (9) and the United Kingdom (10), which included applying the dye to cavities created by dental students and deemed caries-free by their clinic instructors; the experiments showed that 57% to 59% of cavities at the enamel-dentin junction had dye-stained dentin.

This finding suggested that instructors' clinical assessment was commonly incorrect and that persistent deterioration was widespread. The result was drawn despite the fact that the laboratory portion of the U.K. research did not associate dye-stained material with infection, but rather with reduced levels of mineralization, with or without infection. (10). Interestingly, all of the writers showed particular concern for the amelo-dentinal junction. Notably, the researchers believed that dye staining more than half of the cavity pulpal floors that the instructors judged complete was not a good indication that further dentin should be removed since it would expose pulpal tissues unnecessarily.Caries-detecting stains differentiate between vital and non-vital teeth's demineralized and mineralized dentin. Outer carious dentin is stainable because the irreversible breakdown of collagen cross-linking loosens the collagen fibers. Normal dentin and inner carious dentin do not have stained collagen fibers because they are thick and undamaged. In other words, dyes do not stain microorganisms but rather the organic matrix of weakly calcified dentin. (11) (12). By comparing the site of dye-

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stainable dentin with tooth mineral density, Yip and colleagues (1994) verified the lack of specificity of caries detector dyes (13).

The dyes could not stain bacteria, but they could detect the bacterial front and stain collagen that was connected to a less mineralized organic substrate. One important discovery was that when the dyes were applied to recently removed, caries-free human primary and permanent teeth, the dye was absorbed by sound circumpulpal dentin and sound dentin at the dentin-enamel junction. This is perhaps because these locations often have higher concentrations of organic matrix.

Undoubtedly, a considerable amount of good tooth structure may be lost if these colors are used without understanding their special limitations. Measuring the staining intensity is also crucial when checking for cavities. Color contrast makes it easier to identify carious dentin when tactile discrimination is weak. For example, other dental locations where a tactile evaluation is unclear may have the same dye intensity that is shown to be predictive of caries.

Methods

Ethical and Subject Selection

This split-mouth, prospective, randomized study adhered to the recommendations and approval of our supervisor, Dr. Nabra F. Salih. Patients also gave their ethical approval for patient applications and registration. The research was carried out in the clinics of Thi Qar University/College of Dentistry and involved 70 willingly registered patients with deep-seated caries, ages 18 to 40.

Every participant had standard dental care, an informed oral consent form was completed beforehand, and they were all informed of the investigation's goal and design.A thorough medical and dental history was documented using the research sheet, which included the patient's name, age, tooth number and location, sex, and diagnostic outcome. The trial started on October 26, 2023. Enrollment started on November 15, 2023.

Sample criteria

One tooth from each of the 70 patients with occlusial or proximal caries made up the final sample. Age: 18 to 40 with no underlying medical conditions. aggressive, acute dentinal caries that affects the proximal and/or occlusal surfaces of permanent molars

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and premolars; this kind of caries is deep-seated and directly accessible, and there are no outward indications that the pulp is affected.

Patients with systemic disorders, intra- or extraoral swellings, pulp-related dental caries, periapical pathology, or any beginning caries are excluded.

Study Design

Following a rigorous one-month training session, we performed the clinical procedures for the research. Patients were selected at random after the screening process. One tooth was randomly selected for each individual, and the numbers were distributed in envelopes by a researcher who did not participate in the clinical stage. Seventy teeth from individuals with proximal (P) and/or occlusal (O) carious lesions were generated by this randomization. The same 70 teeth that underwent a clinical evaluation for the presence of caries are analyzed using caries detector dye (CDD).

Clinical procedures

The hardness of dentine was measured using a dental explorer.To make sure there was no pulp involvement, pre-operative pulp vitality tests were conducted, a local anesthetic was administered, and an operator began the excavation procedure. After this stage was finished, a probe and CDD were used to obtain two measurements under direct eyesight. Starting with a slow-speed hand piece, a flat surface was produced and the dentin lesion was exposed for both the proximal (B) and occlusal (A) cavities. The caries dentin was then manually removed using normal round steel burs utilizing a contra-angle hand piece with a speed-reducing 400 rpm. Each tooth was examined with a dental explorer until either a leathery-hard texture was achieved or a sharp scratching sound was detected in every tooth (14) (15). As a novice examiner, the various pupils have completed the caries removal procedure in every topic. Three observers then used the Kidd et al. (16) criteria to do a direct visual evaluation of the cavity in order to successfully remove the caries. Following caries removal, the teeth were examined and inspected, and by assessing their color and consistency, it was determined that all caries had been removed (probing of the excavated cavity would be performed until a firm surface felt).

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Figure (1): clinical steps by exploring the cavity and using hand piece to obtain flat leathery surface

Regarding Groups 2Following visual inspections, a CDD was used to determine if residual caries was present or not. While noninfected dentin may not absorb much of the dye, infected demineralized dentin will exhibit distinct dye stains (17) (18). A tiny brush was used to apply the dye to the occlusal or approximal cavities, and a 5-second water spray was used to remove it after 10 seconds. After that, the cavities were carefully inspected for any dentin sites that had been dyed. We determine if there is a positive or negative caries outcome after evaluating the cavity using the two methods..

Figure (1Figure(2): caries detector dye (CDD) application

Evaluations

Clinical Evaluation: Using direct eyesight, the skilled lone operator assessed the caries excavation. Each tooth's color score interpretation was determined using Y. Hosoya's 2007 (19) methodology. as follows: (1) groups that are black (or dark brown), (2) groups that are brown (or yellow brown), and (3) groups that are yellow (or light yellow).The three categories for caries hardness were (a) hard, (b) medium, and (c) soft. (Soft: caries-infected dentin was readily removed with hand tools; medium: carious dentin ranged between the aforementioned classifications; hard: carious dentin needed the use of both burs and hand instruments for removal).

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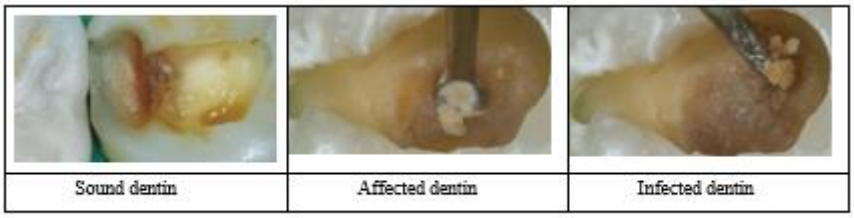

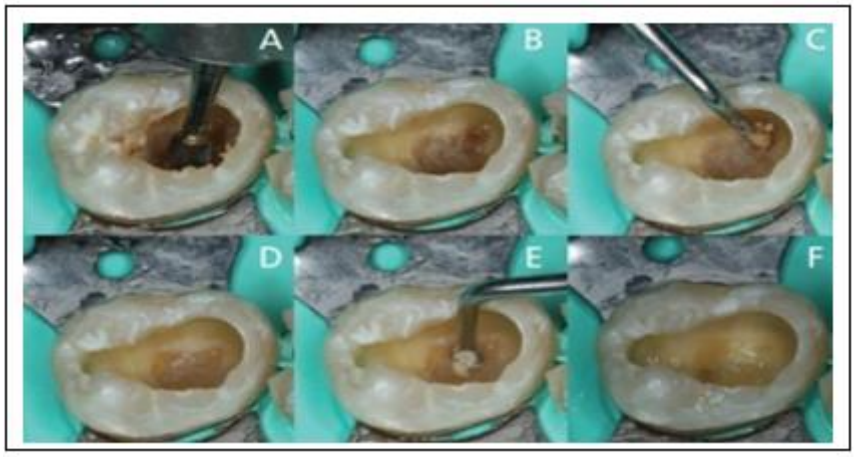

Elimination of carious tissue involves several steps: employing a round bur to establish sound dentin at the periphery (A); retaining a thin layer of infected dentin on the pulpal floor (B); excising the infected dentin (C); addressing the affected dentin on the pulpal floor (D); avoiding the removal of the affected dentin [not advisable] (E); and exposing the pulp chamber in proximity to the sound dentin (F).

Result and Discussion

Participation rate

Gender	Participants No.	%
Males	**50**	**71%**
Females	**20**	**29%**

Table(1): Participation rate between genders

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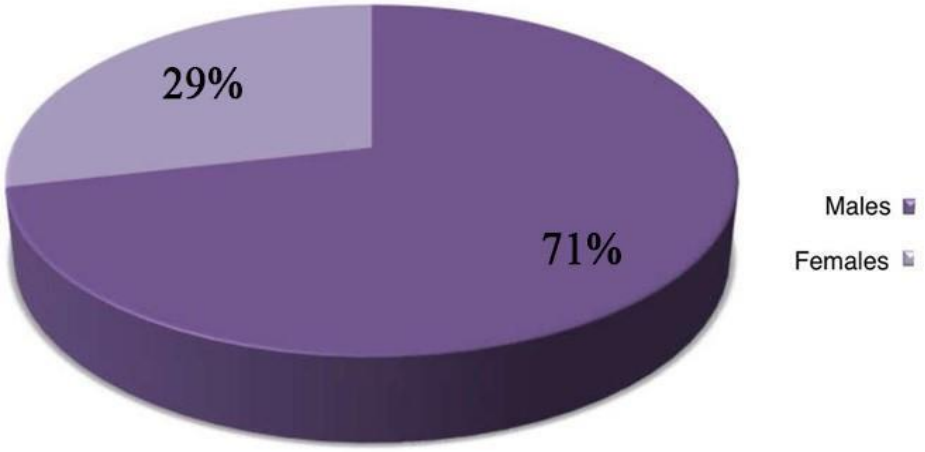

Graph(1) : participation rate between genders

Average age

Average age	**28 year**	
Less than 28 of males	29	41%
More than 28 of males	21	30%
Less than 28 of females	13	19%
More than 28 of females	7	10%
Total	70	100%

Table(2): average ages between participants

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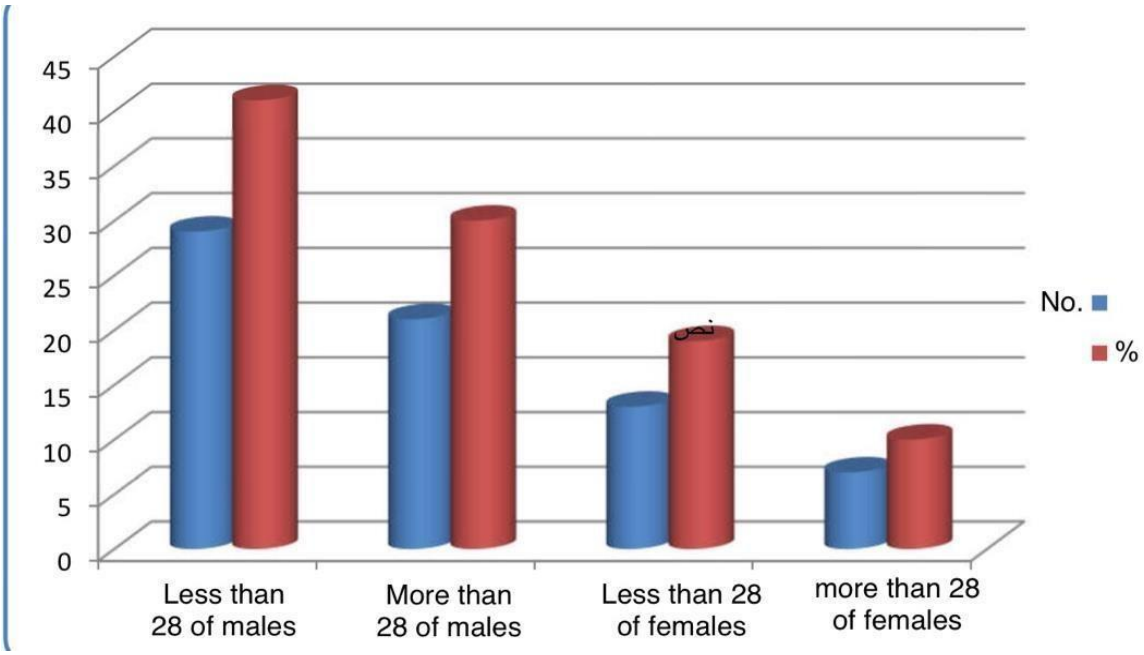

Graph(2) : average ages ,this demonstrates the ages that we have been focused in our study

Paired Samples Statistics

Samples	arithmetic mean	ParticipantsNo.	Std.Deviation	Std.Error mean
After dye Application	0.71	70	0.455	0.054
Before dye Application	0.56	70	0.500	0.060

Table(3): Paired Samples Statistics: this Table represents The number of people who have passedThe dye was tested on them (70 individuals) before using the dye and after using the dye.

It was found that the arithmetic mean after the dye reached (0.71), while the arithmetic mean before the dye reached (0.56) and by (0.15)difference ,which indicates that the dye has an effective effect in conducting the test on the teeth as a beginners evaluators

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Paired Samples Correlations

Samples	Participants No.	Correlation	Sig.
Before & after dye	70	0.391	0.001

Table(4): Correlations between matched samples

Paired Samples test

	Arithmetic mean	Std Deviation	Std Error mean	Lower	Upper	T test	df	Sig.
	0.157	0.528	0.063	0.031	0.283	2.488	69	0.01

Table(5): paired Samples test : Since it is evident from the above table that the value of the (T) test attained (2.488), the crucial part of this test is to demonstrate the efficacy of the dye on the teeth in table (5) (Paired Samples Test).

Discussion

We used two diagnostic techniques: the first is clinical, which is utilized by students, and the second is dye-based, which is more precise (21). As we previously found, we chose 70 samples of cavities with occlusial and proximal deep-seated caries, 20 of which were female (29%), and 50 of which were male (71%). Standards were followed throughout the patient selection procedure, therefore there are no differences amongst the patients. We made a clinical diagnostic on individuals between the ages of 18 and 40 using a probe and the surface color and strength. The condition was then ascertained using the dye, which colors the sick dentin but not the affected dentin. (21). Following that, we gathered and examined their data. The average age was 28 years, and the 70 subjects who had the dye test had a mean of (0.71)positive, compared to

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the arithmetic mean of (0.56) before to the dye use, with a difference of (0.15), indicating Compared to the traditional procedure used by novices, the dye has a more effective impact when testing teeth. The current research found that the use of CDD, which has an average of 0.71 higher than the other approach, considerably increased intra- and interobserver agreements.In this investigation, CDD had the greatest accuracy value. A paper titled "Diagnosis and Assessment of Dental Caries Using Novel Bioactive Caries Detecting Dye Solution" was published in Biomedicines in 2023 by Shashirekha Govind et al. According to its content, CDD is more helpful and successful in clinically identifying dental caries. Therefore, based on our research's findings, we concur with this study.

We somewhat disagree with this study because of another study that was published in the Journal of Dentistry (Tehran, Iran) 7 (2), 71, 2010 by M Javaheri, S Maleki-Kambakhsh, and Sh Etemad. The study states that, within the constraints of the current study, our results show that the current detector dyes are not reliable enough to be used as the sole diagnostic technique only in detecting carious lesions.

In a different investigation, Lennon et al. (22) found that caries detector dyes and the traditional caries removal method were equally effective in detecting dental cavities and getting rid of bacterial infections.However, based on the findings of our investigation, this is untrue. The effectiveness of CD dyes on permanent and deciduous teeth was investigated by Hosoya et al. (23). They claimed that propylene glycol's strong diffusional property and reduced molecular weight and surface tension in CD might allow the dye to penetrate sound dentin more deeply. We may recommend this study so that it can be investigated to determine the flawed outcomes from dye usage

Conclusion

This study shows the importance of using the CDD for the beginner students and that it has a greater effective impact for its use in diagnosis and its impact in identifying deep caries is greater than the usual clinical diagnosis among students, and this is only at the student level, so the percentages could be different if the evaluators have more experience

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