Research Article

Comparison of Two Clinical Approaches FDI Vs Cars Visual Criteria for Secondary Caries Evaluation in Permanent Posterior Teeth

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Abstract

Background: Secondary caries arise at the contact of a natural tooth and a prosthetic repair. The present investigation employed two clinical methodologies, namely Caries associated with restoration or sealants (CARS) and the International Dental Federation (FDI), to evaluate and manage secondary caries in permanent posterior teeth.

Objective: The goal of this research is to compare the diagnostic efficacy of FDI and CARS visual criteria for assessing secondary caries in permanent posterior teeth, to identify the more reliable and effective clinical approach for improved treatment planning and patient outcomes.

Method: This was conducted at the School of Dentistry Pakistan institute of medical sciences Islamabad, after approval from the ethical committee. The sample size is 160 patients. In this study, two clinical criteria being assessed included one representing the FDI system which includes the marginal staining, marginal adaptation, and caries' recurrence, while another one was Caries associated with restoration or sealants (CARS) based on ICCMS (International Caries Classification and Management System) for evaluation and treatment of secondary caries.

Results: A total 650 restorations were assessed, with a mean age of 30.83 years (SD±2.68). While comparing, there was a strong correlation to the presence of caries lesions (Rho=0.64), and for Marginal adaptation, it was (Rho= -0.45), which depicts a weak inverse correlation. There was a moderate correlation between the two criteria (Rho=0.64,) The majority of CARS visual criteria decisions recommended no treatment in comparison to FDI criteria

Conclusion: It is concluded that the FDI system is a more aggressive approach, suggesting a higher number of restoration replacements than the CARS which is less invasive. As a result, the method used to assess secondary caries may result in more or less invasive suggestions for treatment.

Introduction

Secondary caries is defined as "lesions at the margins of existing restorations.[1] This could happen if the patient doesn't take care of their caries properly or if the restoration margins aren't good enough to keep acidic fluid out of the space between the tooth and the replacement which causes decay of restoration material.[2-3] Secondary caries is often cited as the main long-term cause of restoration failure, especially for resin-based materials.[4] Because of secondary caries, it is normal for dental restorations to need to be replaced or fixed

Secondary caries can be difficult to identify because of gaps between the filling material and the tooth surface, and stained margins on resin-based composite restorations.[5] Study by Jabbar Hussein Kamel et.al shows that the prevalence of secondary caries in patients was found to be 53%, highest prevalence in the lower arch and class II restoration and more in amalgam than composite restoration.[6]

An essential first step in making an appropriate assessment and treatment choice for outdated restorations is to evaluate the repaired tooth. Although additional instruments may be used, visual inspection is the most common technique for identifying secondary caries. The presence of discolored margins and gaps between the restoration and tooth surface makes it challenging to distinguish between carious lesions and demineralization restorations. As a result, visual criteria are employed to improve the objectivity of the diagnosis process.[7]

In 2007, the International Dental Federation (FDI) issued a visual criteria that analyze marginal staining, marginal adaption, and caries presence. However, these qualities may be significant to the FDI criteria but many dentists and researchers consider marginal staining and marginal adaption are not directly related to caries lesions.[8] According to the research, restorations with good FDI criteria should use a minimally invasive repair procedure, whereas restorations with poor FDI criteria should be replaced.[9] The Caries Associated with Restorations and Sealants (CARS) criteria is yet another set of standards to consider. When evaluating the success of a restoration, the CARS criteria only consider factors linked to caries which involves visual assessment of restoration from sound teeth surfaces to visual defect formation to distinct cavity formation.[9]

Among the existing criteria, CARS appears to be the most appropriate since it considers factors like demineralisation surrounding a defective restoration, amalgam shadows that are inconsistent with caries lesions.[10] According to a study by Stolfo Uehara JL et.al, the FDI criteria for caries recurrence and marginal adaptation trailed behind the CARS criteria in terms of specificity and accuracy in detecting caries surrounding restorations.[11]

Nowadays, dental professionals may choose minimally invasive repair procedures for treating restorations with secondary caries by using clinical evaluation criteria,

therefore extending the functional, anatomical, and cosmetic longevity of attractive posterior direct restorations. Minimally invasive therapy is used to treat dental disorders such as secondary caries with the least amount of harm. This idea of treating the restored teeth with minimally invasive therapy includes repair, which has gained popularity for its benefits such as preserving good tooth tissue, cutting down on clinic visits, improving patient compliance, resulting in lower costs, and extending the lifespan of the restoration.[7] Research reveals when opposed to replacing all of the restorations, repairs take less time, don't cause as much anxiety, and use less local anaesthesia.[12]

The incorrect diagnosis can lead to inappropriate treatment of teeth that have been permanently repaired. Therefore, it is important to look at how various techniques for secondary caries diagnosis affect the framework for choosing dental treatment options.[13] This study is done to compare two visual criteria one of them is the International Dental Federation system (FDI) which incorporates marginal staining, marginal adaptation, and caries' recurrence, while another one was Caries associated with restoration or sealants (CARS) based on ICCMS for analysis of secondary caries and treatment decision of already restored posterior teeth. Our working hypothesis is that the detection of caries lesions around restorations using two distinct visual approaches has an impact on the choice to replace the restoration as well as the choice of treatment modalities. This study investigates the FDI and CARS visual criteria for secondary caries in permanent posterior teeth, aiming to discern their diagnostic efficacy. The findings will contribute vital insights into refining dental assessment practices, guiding treatment decisions, and improving overall patient care.

Methods

After the approval of the Institution's Ethical review committee(SOD/ERB/2022/08), in this cross-sectional investigation, two visual clinical criteria, which include International Dental Federation (FDI) and Caries associated with restoration or sealants(CARS), were compared to evaluate repaired teeth. Patients part of the study were 160 based on the following Inclusion and Exclusion criteria. The Non-probability consecutive sampling was used in this study. Using the WHO calculator, the

sample size was determined to be 160 with a 95% confidence level, population proportion of 11.6%, and an absolute precision of 5%.

1. Individuals who came to the School of Dentistry (PIMS) for dental care.

2. Patient with good dental hygiene assessed clinically.

3. Aged between 18–60 years.

4. A permanent posterior tooth of the patient has at least one composite or amalgam restoration.

5. Patients who were not under medications like antihistamines, chemotherapy medications, antidepressants, or seizure medications that can compromise oral health.

Exclusion Criteria

1. Patients who presented with a systemic chronic disease that required differentiated care and follow-up.

2. Patients with local and systemic conditions affecting periodontal health.

3. Restorations on teeth that have an abscess, fractures and cracks , fistula, pulp being exposed, spontaneous dental pain history, or mobility.

Informed consent was taken from the patient before evaluation. After evaluating the patients in the well-illuminated room with a professional dental chair, they went into dental cleansing that consisted of a low rotation micromotor, rubber cup, and brush with prophylaxis paste. All patients' tooth surfaces were initially assessed the Decayed-Missing-Filled Teeth index (DMF-T index) was calculated, and caries activity was recorded, and then all patients were assessed with both visual criteria by a single examiner.

FDI criterion (International Dental Federation) criteria included: caries presence, marginal adaptation, and marginal staining.

Before the assessment, all surfaces were dried. For each restoration, each factor; caries existence, marginal adaption, and marginal staining was given a score from 1 to 5:1= excellent; 2 = good; 3 = sufficient/satisfactory, 4 = unsatisfactory (but reparable), and, 5 = poor (replacement necessary)]. The indication of treatment was based on which of the three factors received had the greatest score. Because amalgam restoration generated endo-genous pigmentation in the toothorder, only marginal adaptability and caries recurrence were studied.

The International Caries Classification and Management System defines the "Caries Associated with Restorations or Sealants" (CARS) criteria.

After 5 seconds of drying by air, the surface was evaluated and graded from 6 ('extensive distinct cavity with exposed dentin) to 0(sound tooth surface). According to CARS criteria, restorations could be treated in one of five ways: (5) replacement, or (4) repair, (3) refurbishing, 2) topically applied fluoride, (1) not at all,

Both FDI and CARS visual criteria were used to evaluate secondary caries. After that, the examiner made the treatment decision after establishing the diagnosis based on the sorted criterion. The following were the outcome variables: evidence of replacement of the restoration and indication of any kind of treatment.

Initially, we evaluated the demographic variables: caries activity, DMF-T, and gender as well as ages (up to or above 30). Next, the frequency of the tooth types , the number of repaired surfaces (one, two, or three surfaces), and the sort of restorative material (amalgam or composite resin) were evaluated. Finally, we evaluated the repairs using the FDI and CARS criterion.

Spearman's rank correlation between two criteria, FDI and CARS, was carried out using SPSS version 23. Spearman's rank correlation analysis was performed, and the chi-square test was employed to compare the options for restoration treatment: repair, replacement, and no treatment at all .

Results

The study comprised 650 teeth with restorations and 160 participants in total. Among the 160 patients, women made up the majority. In the study, there were more patients over 30years. All,650 (100%) restorations were assessed by FDI criteria and re-evaluated for treatment indication by the CARS criteria. Most of the restorations were composed of composite resin. [Table 1]. Next, a correlation was computed between the scores derived from the FDI criteria and the CARS criteria. The Spearman correlation coefficient (Rho) related to the presence of caries lesions was found as 0.64 (95% CI= 0.59-0.69) which shows a strong correlation and for Marginal adaptation, it was 0.45 (95% CI= -0.12- 0.3)

Table 1: *Variables data*

		N	Percent
Gender	Male	71	45%
	Female	89	55%
	Total	160	100.0%
Age	Less Than 30	79	49.4%
	More Than 30	81	50.6%
	Total	160	100.0%
DMF-T Index	Less Than 4	5	3.1%
	Equal To 4	19	11.9%
	Greater Than 4	136	85%
	Total	160	100.0%
Caries Activity	Carries Active	121	75.6%
	Carries Inactive	39	24.4%
	Total	160	100.0%
Type Of Teeth	Upper premolar	93	14.3%
	Upper Molar	246	37.8%
	Lower Premolar	55	8.5%
	Lower Molar	256	39.4%
	Total	650	100.0%
	Lower Arch	73	45.63%
	Total	160	100.0%
Number Of Surfaces	1 Surface	214	32.9%
	2 Surface	215	33.1%
	3 Or More Than 3	221	34.0%
	Total	650	100.0%

Table 3: *The relationship between the suggested treatment choices for assessment restorations when comparing the FDI and CARS criterion*

FDI Treatment	CARS Treatment			Total
	No treatment	Repair	Replacement	
No treatment	426	0	0	426
Repair	136	7	0	143
Replacement	10	58	13	81
Total	572	65	13	650

Spearman Rank's Coefficient -= 0.64 (95% CI= 0.59 - 0.69)
Chi- Square analysis= 336.400 (p < 0.05)

which depicts as weak inverse correlation. [Table 2].

Next statistical analysis was done between the treatment decisions as a whole between two criteria, which came out as moderate correlation as Rho was 0.64 (95% CI= 0.59-0.69) and the chi-square test was significant (p< 0.05). Out of 650 total assessments, the no of replacement decisions done through CARS criteria came out to 13 (2%), while FDI suggested more replacements, which shows the aggressive and less invasive approach of FDI visual criteria. Moreover, about 88% of assessments through CARS visual criteria suggested no treatments but this value went down to 65% for the FDI system.[Table 3].

Table 2: *Spearman correlation coefficient (Rho) for CARS and FDI Criteria subcategories*

FDI* Marginal adaptation index	CARS* index							Total
	sound tooth surface	first visual change	distinct visual change	carious defect< 0.5	marginal caries	distinct cavity	extensive distinct cavity	
Clinically Excellent	7	8	28	3	3	4	1	54
Clinically Good	24	67	98	92	11	16	1	309
Clinically Satisfactory	12	58	36	45	9	2	2	164
clinically unsatisfactory	23	27	17	17	10	8	2	104
clinically poor	5	1	2	2	4	3	2	19
Total	71	161	181	159	37	33	8	650
Spearman's rank coefficient (Rho) = -0.45 (95% CI= -0.12- 0.3)								
Caries Recurrence	CARS INDEX							
Clinically excellent	58	52	55	104	0	0	0	269
Clinically good	11	56	41	31	0	0	0	139
Clinically satisfactory	2	49	84	9	1	0	0	145
Clinically unsatisfactory	0	0	1	12	4	5	0	22
Clinically poor	0	4	0	3	32	28	8	75
Total	71	161	181	159	37	33	8	650
Spearman's rank coefficient (Rho) = 0.64 (95% CI= 0.59 -0.69)								

International Dental Federation(FDI)*
Caries associated with restoration or sealants (CARS)*

Discussion

Secondary caries is not an uncommon condition and it is more prevalent in the lower teeth 6 thus needs evaluation criteria for assessment and indication for restoration. Many methods were used historically for the esthetic misfit and restoration which included imaging technology mainly.[15] This study is the first of the type of study comparing clinical criteria. The ICDAS provides a detailed set of criteria for identifying CARS in the context of dental restorations and sealants.[16] The CARS criteria appear to be the most applicable to current practice among the criteria presented in the literature. These criteria assess the severity of the disease and decay process and also the caries activity, which highly influences the indication of treatment whether just applying fluoride paste or replacing the whole esthetic.[17]

While assessing the correlation between two criteria in subgroups, we didn't include the marginal staining as it can cause intrinsic tooth pigmentation[18], and many studies proved that it is least associated with the development of secondary caries.[19] One such study carried out to determine the effectiveness of marginal ditching and staining as diagnostic indicators of secondary caries around amalgam restorations was done, in which on extracted human teeth, 124 Class I amalgam restorations were put through standardized clinical tests. Only 16% showed grey staining with low specificity and sensitivity. [20]

Correlational data between the recurrence of caries, a subset of FDI and CARS criteria revealed a high positive relationship. This could be explained by the fact that the FDI guidelines for caries recurrence and the International Caries Detection and Assessment System (ICDAS) employ comparable sets of parameters. Furthermore, similar to CARS, lesion severity is dictated by elements including the existence of dentine cavities and enamel opacities.

Our study depicted an inverse correlation between CARS criteria and marginal adaptation to a point of Rho = -45, study by Signori C et al:, by showed some moderate correlation (Rho = 0.457).[14] One reason that is explained by the involvement of more than one surface, overhanging margins leading to lack of adaptation, and accumulation of biofilm around the restored surfaces make it more vulnerable to an exaggerated response that lacks in CARS criteria. However, researchers and clinicians continue to disagree on how to distinguish between the presence of gaps and caries lesions at the tooth-restoration junction.[21,22]

Analyses of the data revealed that, the FDI criteria suggested larger number of replacements than the CARS criteria. As a result, the chosen criterion has a direct bearing on whether or not to replace the repair. Although this claim is not supported by the majority of the research, the available evidence shows that less invasive procedures should be utilised when considering the advantages of the patients into consideration.[23] It is important to note that in contrast to the CARS criteria, we included marginal staining and marginal adaptation in the indication of replacement while calculating the score, which yielded in higher no of replacement indications, although this is a deeper evaluation but not beneficial for the patient's cost perspective. We followed this approach because many dental surgeons take marginal defects as caries' indicators, but data proves that they are not accurate and sensitive markers.[24]

The clinically significant values in the FDI system, which take into account the existence of caries and marginal adaptation, are 4 (repair) and 5 (replacement), respectively because a restorative intervention is often necessary for these situations. Though marginal staining alone is not considered a clinically significant concern in posterior teeth, scores 5 and 4 on the FDI for marginal staining should be carefully examined. The CARS ratings 3,2 and 1 are only clinically relevant, if the caries lesion surrounding the restoration is active (active lesion). In these cases, topical fluoride therapy is recommended. Additionally, since they are associated with the need for restorative replacement or repair, ratings 4 through 6 are also clinically important.

The accuracy of the detection method is commonly described when assessing its validity against a gold standard, which should be an unbiased assessment of the test carried out according to a specified protocol and applied to all included objects.[25] However, due to a paucity of clinical noninvasive reference standard procedures, there is no gold standard for evaluating caries lesions surrounding restorations.[26]

Although the FDI criterion seems to be less conservative than the CARS criteria and indicates a higher percentage of restoration replacement, it is impossible to find the

best criterion for evaluting the restoration through cross sectional investigation remain unattainable, potentially leading to inappropriate treatment. To integrate evidence-based dentistry, further research on how diagnostic techniques affect choices about dental treatment should be done. The purpose of the research was to investigate several clinical strategies that may be used for secondary caries detection and treatment; hence this is the only context in which the findings should be interpreted.

The study's use of a single examiner to evaluate both restoration criteria presented the main limitation. We think that adding more examiners would lead to other variants that could be possible. The lack of a means to assess the examiner's capacity to consistently record the same circumstances over time is another limitation of this study. Yet, it appears that the use of clearly stated standards based on a scoring system with a comprehensive explanation can validate the examiners' similarity.

To reduce measuring variances, standardized measurements are utilized. Additionally, it has previously been shown that the intra-examiner reliability for caries diagnosis is strong and maintains this level over time.

Conclusion

In summary, the choice of whether or not to intervene in the restoration process is directly influenced by the visual criteria used for assessment. From the standpoint of the patient, the application of FDI criteria led to inappropriate treatment and increased cost. Except marginal adaptation and marginal staining, the FDI system is used similarly to CARS, indicating that this finding has made the use of CARS criteria more beneficial. As a result, the focus has shifted to a less aggressive, non-invasive, and economical approach to patients' welfare.

Authors' Contribution:

AW: Conception and design of the study, drafting of the manuscript, analysis, and interpretation of data, revising the manuscript critically for important intellectual content

SAK: Conception and design of the study, and drafting of the manuscript with critical intellectual input.

SA: Acquisition, analysis, and interpretation of data.

M: Acquisition of data, drafting of the manuscript

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