Research Article

Prevalence of Secondary Caries Around Posterior Restoration

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Abstract

Background: Secondary caries is defined as lesions at the margins of existing restorations and is considered as a major reason for their replacement which, if it is left undiagnosed it may lead to loss of vitality of a tooth with many factors contributing to it.

Aims of the Study: The present study aims to determine the prevalence of secondary caries around posterior restorations in patients attending Tishik Dental Hospital University in Erbil city/Iraq.

Methods: A descriptive study was conducted among 61 patients with a total of 113 posterior restorations that are older than one year. Information regarding the presence or absence of secondary caries was noted with the age of the restoration, their types are based upon an extension of the restoration and the restoration material being used either amalgam or composite.
Statistical analysis was done using a t-test for difference and a chi-square test for relations.

Result: Prevalence of secondary caries was found to be (53%) among the understudy patients, restorations in the lower arch showed the highest prevalence, class II restorations had the highest prevalence, Amalgam restorations had a higher occurrence of secondary caries more than composite restoration, which had an age average of less than five years.

Conclusion: Restorations located in the mandible, especially the first molars, showed the highest prevalence of secondary caries, restorations involving the occlusal with the proximal margins had the highest prevalence, their occurrence was highest in restorations being in a period of less than five years.

Keywords: Posterior Restoration; Secondary Caries; Amalgam; Diagnosed

Introduction

Secondary or recurrent caries [1] has been defined as the primary carious lesion found adjacent to the existing restorations [2], which occurs after a period of time in which the restoration is in use [2] or caries associated with restorations or sealants (CARS). According to G.V Black, which state that occurs following microleakage or inadequate removal of primary caries [3].

Secondary caries is a complex, multifactorial process, interweaving the various causes of conventional caries with the specific characteristics of the restoration and restorative material involved.

Secondary caries may be [1] casually associated with a defective restoration mainly via gaps between the restoration and the tooth allowing acidic fluids or biofilm to enter the interface or [2] casually associated with an intact restoration, e.g., via a lower buffering capacity of the restoration compared with the tooth hard tissue or [3] not casually associated with the restoration at all, but mere primary caries adjacent to existing restorations mainly when the caries process has not been sufficiently addressed on a patient level, and the surface next to the restoration becomes carious as a result of this ongoing caries activity [4-7]. Most researchers indicated that secondary caries was predominantly found on the gingival margin

of posterior restorations while seldom on the occlusal surface of class II restorations [8,9].

Researches have shown that a great majority of secondary carious lesions begin on external surfaces adjacent to the dental restorations, in which this finding gives a great advantage of visual-tactile examinations of secondary caries to detect it and provide the ability to have adequate control of carious lesion to deactivate it and prevent the loss of tooth vitality and causing failure of the restoration [10]. While recent in-vitro data found near-infrared light transillumination potentially useful to detect secondary lesions similar to radiographic assessment and to be superior to visual-tactile detection [11], overall, all these methods are useful to detect secondary caries.

Materials and Methods

Selection criteria

The research has been conducted for predicting the prevalence of secondary caries around posterior restorations, clinical diagnosis of 61 patients who attended Tishik Dental hospital at Tishik University in Erbil city generally and at Conservative department especially. Only patients with previous dental restorations which were done at one year and above on posterior teeth involving both arches sound and immobile teeth.
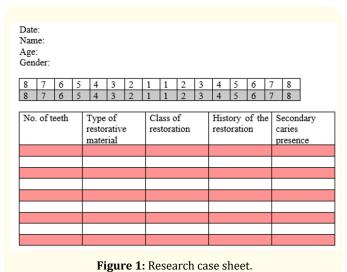
Materials

- Dental chair (FOSHAN JOINCHAMP Medical Device Co. LTD, China)
- Disposable dental mirror
- Disposable mouth prob
- Mobile camera
- Disposable glove
- Disposable face mask.

Essential agreement

Verbal Consent from each patient who has been clinically diagnosed was taken before starting work, agreement from the conservative department of Tishik Dental hospital had also been considered.

Sample design

Patients who attended Tishik dental hospital with varying chief complaints were taken as a sample, who had done posterior res-

torations either amalgam or composite material, they agreed to participate in the study, they had been chosen to be diagnosed clinically to evaluate the presence or absence of secondary caries. Examination case sheets (Figure 1) were used for taking complete history about the selected posterior restorations as a sample study of each patient including name, age, gender, number of teeth which were restored and its date of being done, type of restoration (class I or class II) and their materials (Amalgam or composite).

Figure 1: Research case sheet.

Exclusion criteria

Patient with a history of the restoration of less than one year and an anterior tooth being restored, crowns and bridges were not included in the study sample.

Secondary caries assessment

Secondary caries diagnosis was made based upon clinical diagnosis using visual-tactile examination method, which is potentially useful for detecting secondary caries (although it is inferior to Infrared light transillumination and radiographical assessment) for all the surfaces of the restorations to seek the presence of frankly cavitated carious lesion adjacent to restorations and detached discolored cavo-surface and margins of the restoration, which are all localised defects that lead to clinical diagnosis of secondary caries.

Data collection

Verbal consent was taken from all participating patients to fill the case sheet; they were asked to sit in the dental chair in an up-

right position, then an intra-oral examination of posterior restorations under dental chair light source with researchers wearing gloves and mask as a protective measure. Visual-tactile examination was done by using a sterile disposable mirror and probe for all surfaces of the restorations to find carious lesions, including soft and hard dental carious lesions adjacent to the restoration; all restorations were documented on case sheets, photographed by using a mobile camera as graphical evidence.

Finally, all the data were analyzed using spss program version 24, and the results will be compared between patients with different variables with a statistically significant level of p < 0.0f, the results will be presented as percentages, frequencies in tables and analyzed using paired t-test.

Results

Sample

The research was done on a total of 61 patients with a mean age of (34.04) in which 28(46%) were male, and 33(54%) were female, in which an age range between 18-70 years patients was taken, the total number of teeth being diagnosed were 113 posterior teeth mainly Class I and Class II restorations since it's the mostly done on posterior teeth sound with no mobility, so the ratio of Class II restorations was higher than Class I as demonstrated in Table 1, sixty-eight out of one hundred thirteen teeth being diagnosed were Class II. While only forty-five out of one hundred thirteen were Class I restorations which comprise (39.8%) of the sample being taken. The one hundred thirteen teeth that were diagnosed were mostly amalgam, in which according to our statistical analysis, 74(65.5%) were amalgams while composites were only 39(34.5%) teeth, as shown in table (1).

Patient No.	Gender		Age range	No. of teeth being diagnosed	Restoration Class		Type of the restorative material	
	Male	Female	18 - 70	113	Class I	Class II	Composite	Amalgam
61	28(46%)	33(54%)			45(39.8%)	68(60.2%)	39(34.5%)	74(65.5%)

Table 1: Study-sample information.

Prevalence of secondary caries according to tooth distribution

The posterior restorations were divided according to four quadrants and then numbered according to FDI World Dental Federation notation which is shown in table (2), lower right first permanent molar teeth were the most commonly diagnosed restorations with a frequency of 23(20.3%), least number of restorations being diagnosed were belonging to the third molars including the upper right and the lower right third molars with a frequency one tooth comprising (0.9%) for each one, the lower left first molars (36) were the second most commonly diagnosed teeth as shown in table (2) so that it composes of 22(19.4%) teeth of all the sample, the second least diagnosed teeth were upper right and left first premolars and lower left second premolars so that all of them were composing of two teeth(1.8%), the sum of all the restorations being diagnosed in the lower arch were higher than the upper arch as shown in table (2) so that a great difference can be seen through arches for example, a sum of 44 restorations that were diagnosed belonged to upper arch while 79 restorations belonged to lower arches.

Table 2 shows the age range of the restorations through each type of restorations in teeth that have been diagnosed through the research period; the broadest age range of restorations were one to eighteen years that belonged to the lower molars, including the first and second molars in each quadrant in the lower arch. In contrast, the narrowest age range of restorations was found in third molar teeth that are according to sample which was taken in which two-third molars had been diagnosed that were upper and lower right third molars which had a history of one year ago and according to table (2), oldest restorations were found in the lower arch than on the upper arch.

The prevalence of secondary caries around posterior restorations based on a sample size of 61 patients and 113 teeth were found to be 60 teeth out of 113 clinically diagnosed restorations had clinical signs of secondary caries that gives a frequency of (53%) in Erbil City, only f3 out of 113 had no sign of secondary caries as shown in table (2), according to the data analysis being done, the most frequently diagnosed teeth with secondary caries were lower right first molars with a prevalence of 13(11.5%) out of 60, and in the second place was found to be in lower left first molars with a frequency of 11(9.7%) out of 60 teeth. However, the least number of secondary caries was found in upper right second

premolars, and upper left first premolars, upper right third molars, lower right first premolars, and lower right third molars in which all the teeth had a frequency of only 1(0.9%) tooth for each tooth out of 60 teeth.

According to table (2), restorations that were done in the lower arch had a higher prevalence of secondary caries than on the upper arch.

Teeth No.	Frequency	Age of Restoration Range (Year)	Secondary Caries Presence
14	2(1.8%)	4-6	2(1.7%)
15	3(1.8%)	2-7	1(0.9%)
16	9(8.0%)	1-15	3(2.6%)
17	5(4.4%)	1-3	3(2.6%)
18	1(0.9%)	1	1(0.9%)
24	2(1.8%)	10-13	1(0.9%)
25	7(6.2%)	2-13	4(3.5%)
26	11(9.7%)	1-13	5(4.4%)
27	4(3.5%)	1-10	3(2.6%)
36	22(19.4%)	1-18	11(9.7%)
37	11(9.7%)	1-18	5(4.4%)
45	2(1.8%)	6-12	1(0.9%)
46	23(20.3%)	1-18	13(11.5%)
47	10(8.8%)	1-18	6(5.4%)
48	1(0.9%)	1	1(0.9%)
Total No.	113(100%)	Prevalence of secondary caries	60(53%)

Table 2: Prevalence of secondary caries according to teeth distribution.

Prevalence of secondary caries according to restoration classes

The prevalence of secondary caries based on restoration classes has been found that 19 Class I restorations showed clinical sign of secondary caries, while in Class II, 41 restorations out of 60 had secondary caries, as shown in (Table 3).

Restoration Class	Class I	Class II
Prevalence of Secondary Caries	19(16.8%)	41(36.2%)

Table 3: Prevalence of secondary caries according to restoration Classes.

Prevalence of secondary caries according to the restorative material

Secondary caries had also shown variations according to the restorative material being used as shown in table (4), in which it has been observed that amalgam had a higher number of secondary caries, which is 37(32.7%) out of 74 amalgam filled teeth, while in composite, the ratio was 23(20.6%) out of 39 composite filled teeth.

Restorative Material	Amalgam	Composite
Prevalence of Secondary Caries	37(32.7%)	23(20.6%)

Table 4: Prevalence of secondary caries according to Restorative material.

Prevalence of secondary caries according to restoration age

Restoration age were divided into three groups as shown in table (5), ranging from less than five years and between five to ten years and finally ten years and above, most of the restorations that were diagnosed had a restoration age less than five years while a few old restoration were diagnosed in which it comprised 13 restorations out of 113 had a history of restoration being done ten years and above, the most common restorations age were less than five years that is composed of 81 restorations out of 113 and it was found that 41 restorations showed clinical sign of secondary caries while in comparison to restoration age range between five to ten years in which 19 teeth out of 113 had this restoration history and nine restorations did have a clinical sign of secondary caries, older restorations had the smallest sample size in which only 13 teeth out of 113 had restorations history being done ten years and above and result had shown that from thirteen teeth, only five teeth had clinical sign of secondary caries as shown in table 5.

Restoration Age (Year)	No. of Teeth	Secondary Caries (Teeth)	Prevalence
Less than 5 years	81	41	50.60%
5 - 10 years	19	9	47.30%
10 years and above	13	5	38.40%

Table 5: Prevalence of secondary caries according to restoration age.

Correlation between secondary caries and other variables

The statistical analysis that was done as shown in table (6) that shows us the correlation between secondary caries with the other

parameters and information that were taken from the patient during history taking such as their age and their gender and how long the restoration had been done which were done for every patient when the examination was done, the table shows us there is no sig- nificant correlation between the presence of secondary caries and the age of the patient, so the result of statistical analysis showed no significant correlation between the presence of secondary caries and the other variable as shown in table (6).

Secondary Caries Presence		N	Mean	Std. Deviation	Std. Error Mean	P Values
Gender	Yes	60	1.47	0.503	0.065	0.148
	No	53	1.60	0.494	0.068	
Age(years)	Yes	60	34.43	9.980	1.288	0.646
	No	53	33.58	9.504	1.305	
No. of tooth	Yes	60	11.68	5.522	0.713	0.823
	No	53	11.92	5.909	0.812	
Restoration Class	Yes	60	1.67	0.475	0.061	0.136
	No	53	1.53	0.504	0.069	
Type of Restorative Material	Yes	60	1.62	0.490	0.063	0.368
	No	53	1.70	0.463	0.064	
Age of Restoration	Yes	60	3.98	4.409	0.569	0.608
	No	53	4.40	4.087	0.561	

Table 6: Correlation between secondary caries and other variables.

Discussion

The prevalence of secondary caries conducted in this study was (53%) equal to the frequency of 60 teeth out of 113 total teeth being diagnosed, which was higher than that conducted by (Ansari, 2014) [12] that revealed a frequency of (26%), the reason for this difference could be attributed to the different methodology of study being applied, in their study the teeth were diagnosed as having secondary caries when clinical (visual-tactile) and radiographic signs of secondary caries were present, compared to visual-tactile examination for each surface restoration which was applied in our study.

Our result was higher than (Chomys Zyn-Gajweska., *et al.* 1992) [13] Poland study whose prevalence of secondary caries was reported to be (12-3%), where they only used clinical examination with a dental mirror, explorer and considered any catch up of the tip of the explorer as secondary caries.

Also, our result was higher than (Chestnut., *et al.* 199f) [14] Scotland study that reported prevalence of secondary caries to be (8%) during three years; this difference may be attributed to the young age of understudy subjects and evaluation of recently restored teeth.

Also, our result was higher than (Fitzgeral., *et al.* 1994) [15] US study that reported prevalence of secondary caries was (31%) in restored teeth; this difference with our study may be attributed to the fact that some cases of secondary caries that revealed by direct inspection after removal of restoration failed to be diagnosed through radiographic and clinical examinations.

Tab. (2) revealed that the prevalence of secondary caries according to teeth distribution was highest among lower first molar, which showed the highest frequency of secondary caries; this result was in accordance with (Ansari, 2014) (12) and (Naswah Hinaz, 2020) [16] study where secondary caries was predominantly seen in the posterior region with (47-22%).

In this study, the teeth which showed lower frequency were upper and lower second molars, and the lowest frequency were third molars, left upper and lower second premolars; this result was in contrast with (Ansari, 2014) [12] that revealed the prevalence of secondary caries was higher in upper jaw in the second premolar followed by lower jaw in the first molar. Also, it was in contrast with (Demirci M., *et al.*) [17], where secondary caries distribution was higher in the maxillary jaw (62.4%) than in the mandibular jaw;

also it was in contrast to (Alcaraz M G., *et al*. 2014) [18] where in comparison between amalgam and tooth-colored resin restorations, amalgam fillings had lesser chances of secondary caries in the posterior region of permanent teeth.

Our study showed that permanent molars were reported to have the number one tooth to be prone to secondary caries lower permanent first molar; this result is supported by (Haghani., *et al*. 201f) [19], in which they found that molars reported to have the highest frequency. Table (4) revealed that amalgam had a higher prevalence of secondary caries with a frequency of (32.7%) which was in contrast to the finding conducted by (Ansari, 2014) [12], where the composite resin was found to have a higher frequency of secondary caries more than amalgam that may be attributed to the technical sensitivity of composite resin application and also with the results of clinical studies were amalgam seems to come with lower risk of secondary caries, especially in high caries risk patients as in [18,20].

This study showed that secondary caries presence according to the extension of the restoration was highest in class II restoration with a frequency (36.2%), and lowest in class I with a frequency (16.8%), which is in accordance with (12, 19,21), in which an estimation could be done that class II restorations are more prone to secondary caries as twice as much as class I restorations as shown in table (3), the reason for this is as concluded by (Laccabue., *et al*. 2014) [22], which can be due to the higher number of restoration surfaces susceptible to microleakage in class II restoration, in other words, when more surface is involved, the risk of caries will increase due to several factors which makes it more prone to secondary caries, like proximal overhangs. Also, (Silva., *et al*. 2010) [23] found that restorations with marginal defects will have a high susceptibility for caries to occur at the tooth and the restoration surface.

Restoration age has a great impact on the prevalence of secondary caries, which is defined as an important parameter to be considered; in our study, the highest prevalence of secondary caries was found in posterior restorations, either amalgam or composite with an age less than five years and the lowest frequency were found in restorations with an age of ten years and above as it is shown in table (5), this result was in contrast with (Ansari, 2014) [12] study that showed that the highest frequency of secondary caries

was found in restorations with an age of ten years, while the lowest frequency of secondary caries was found in restorations with a history of less than five years which are newly done as in (Chestnut., *et al*. 199f) study [14] in Scotland where they reported that prevalence of secondary caries was found to be (8%) of recently restored teeth during three years study period.

Concerning age groups

our study did not show any correlation between secondary caries and age, as shown in table (6), this result is in accordance with [12], where the difference between different age groups was not statistically significant at (P = 0.2).

Also, the gender difference in our study was statistically non-significant like that of (2) and (Ansari, 2014) [12] at (P = 0.6). Still, it is in contrast to (Demirci., *et al*. 2010) [17], which showed females were with a higher incidence of secondary caries than males (40.9%).

The rate of recurrent caries in our study is quite different from [19] (8.4%), this difference may be attributed to the material and method variations being utilized; for example, their study had to be done in a radiological center by evaluating bitewing radiographs in which (Wenz., *et al*. 1994) [24] showed that radiographic evaluation of secondary caries is not useful in detection and diagnosis at the enamel lesion so that as a result of this many secondary caries lesions could be left undiagnosed and small degree of demineralization may be invisible due to high radiodensity of enamel tooth structure.

(Goshima and Goshima, 1990) [25] influenced on the effect of radio-opacity of the restorative material being used could affect on the radiographical diagnosis of secondary caries so it may cause faulty diagnosis due to high radio-opacity of the material, may hide a defect in certain projections. Although, recent *in vitro* data found radiographic assessment being superior to visual-tactile detection, but overall, all these methods are potentially useful to detect secondary caries [11].

Detecting secondary caries is a challenge. Most detection methods and criteria have limited accuracy (Brouwer F., *et al*. 2016) [26]. While, of course, detection methods and criteria will not affect the development of secondary caries, they will determine how often a finding is secondary caries or not.

Conclusion

- Teeth located in the lower arch showed a higher prevalence of secondary caries, especially the lower first molar exhibited the highest frequency among the other teeth.
- Class II restorations were diagnosed with clinical signs of secondary caries as much as twice as class I
- restorations.
- Amalgam restorations showed a higher frequency of secondary caries more than Composite.
- Newer restorations, which have a restoration age of less than five years old, showed the highest prevalence of secondary caries more than those with five years and above.
- No significant association was detected between secondary caries and age, gender, restorative material, restoration age, and class.
- Based on the finding of this study, approximately half of all the restorations being diagnosed showed signs of secondary caries.

Suggestions

- Data collection should be extended to involve most of the centers in the Kurdistan region in Iraq to increase sample size rather than Tishik University only.
- Uses of bitewing radiograph as an adjunct to the visual-tactile examination to compare between two techniques and to check which technique shows a higher frequency of secondary caries.
- Follow up for those patients, which were included in the sample, to see if there is any progression of secondary caries.

Bibliography

1. MachiulsKience U., *et al.* "Terminology of dental caries and dental caries management: Consensus report of a work-shop organized by ORCA and Cariology Research Group of IADR". *Caries Research* 54.1 (2020): 7-14.

2. Major IA and Toffenetti F. "Secondary caries: a literature review with case reports". *Quintessence International* 31.3 (2000): 165-179.

3. White SC and Pharoah MJ. "Oral radiology, principle and interpretation. 4th Ed. St. Louis. The C.V. Mosby Co., Chap 15 (2000): 241-253.

4. Haitham Askar., *et al.* "Secondary Caries: What is it? and how it can be controlled, detected and managed?" *Clinical Oral Investigations* 24 (2020): 1869-1876.

5. Kidd EA. "Diagnosis of Secondary Caries". *Journal of Dental Education* 65.10 (2001): 9971000.

6. Schwendicke F., *et al.* "Marginal Integrity and Secondary Caries of Selectively excavated teeth *in vitro*". *Journal of Dentistry* 42.10 (2014): 1261-1268.

7. FerraCane JL. "Models of Caries formation around dental composite restorations". *Journal of Dental Research* 96.4 (2017): 364-371.

8. Mjor IA. "The location of clinically diagnosed secondary caries". *Quintessence International* 29.5 (1993): 313-317.

9. Mjor IA and Quist V. "Marginal failures of amalgam and composite restorations". *Journal of dentistry* 25.1 (1997): 25-30.

10. Hickel R and Manhart J. "Longevity of restorations in posterior teeth and reasons for failure". *The Journal of Adhesive Dentistry* 3.1 (2001): 45-64.

11. Elhenamy K., *et al.* "*In vitro* performance of the Dragnocam for detecting proximal carious lesions adjacent to composite restorations". *Journal of Dentistry* 72 (2018): 39-43.

12. Zahra Jaberi Ansari and Haleh Valizadeh Haghi. "Secondary caries in the posterior teeth of patient presenting to the department of operative dentistry, Shahid Beheshtti Dental School". *Beheshtti University Journal of Dental* 32.2 (2014): 62-68.

13. Chomyszyn-Gajweska M., *et al.* "Prevalence of recurrent caries in three adult communities in Poland". *Community Dentistry and Oral Epidemiology* 20 (1992): 311.

14. Chestnut G., *et al.* "Prevalence of clinically apparent recurrent caries in Scottish adolescents and in5luence of oral hygiene practice". *Caries Research* 29 (1995): 266-271.

15. Fitzgerald RJ., *et al.* "A microbiological study of recurrent dentinal caries". *Caries Research* 28 (1994): 409-415.

16. Naswah Hinaz., *et al.* "Association of Gender and tooth position with secondary caries in class v restoralions- A retrospective analysis". *European Journal of Molecular and Clinical Medicine* 07.01 (2020).

17. Demirci M., *et al.* "Prevalence of caries on individual tooth surfaces and its distribution by age and gender in university clinic patients". *European Journal of Dentistry*. Thieme medial and scienti5ic publishers private Ltd 4.03 (2010): 270-279.

18. Rasines Alcaraz MGR., *et al.* "Direct composite resin 5illings versus amalgam 5illings for permanent teeth or adult posterior teeth". *Cochrane Database of Systematic Reviews* (2014).

19. Haghani J., *et al.* "Frequency of recurrent caries in bitewing radiographies in patients who attended Kerman dental radiology centers, Iran". *Journal of Oral Health and Oral Epidemiology* 5.2 (2015): 90-95.

20. Bernardo M., *et al.* "Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial". *Journal of the American Dental Association* 138.6 (2007): 775-783.

21. Mjor IA. "Clinical diagnosis of recurrent caries". *Journal of the American Dental Association* 136 (2005): 1426-1433.

22. Laccabue M., *et al.* "Frequency of restoration placement in posterior teeth for US Navy and Marine Corps personnel". *Operative Dentistry* 39.11 (2014): 43-49.

23. Silva B., *et al.* "Characteristics of secondary caries lesion around composite resin restorations". *Revista Da Faculdade De Odontologia De Porto Alegre* 51 (2010): 23-29.

24. Wenzel A., *et al.* "Accuracy of visual inspection, 5iber-optic transillumination and various radiographic image modalities for the detection of occlusal caries in extracted non-cavitated teeth". *Journal of Dental Research* 71.12 (2020): 1934-1937.

25. Goshima T and Goshima Y. "Radiographic detection of recurrent carious lesions associated with composite restorations". *Oral Surgery, Oral Medicine, Oral Pathology* 70 (1990): 236-239.

26. Brouwer F., *et al.* "Restoration outcomes after restoring vital teeth with advanced caries lesions: a practice-based retrospective study". *Clinical Investing* 20. 7 (2016): 1675-1681.