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Original Research Article

Amalgam and Composite Use among Dentists and Dental Interns in Saudi Arabia

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Abstract

Aim: *The aim of this study was to detect the use of amalgam versus resin composite restorations placed in permanent posterior vital teeth among dentists practicing in Saudi Arabia and dental interns training in Saudi Arabia.*

Materials and Methods: *318 patients aged ≥ 8 years were randomly selected and clinically examined for amalgam and resin composite restorations placed in permanent posterior vital teeth by dentists and by dental interns in Saudi Arabia. The restorations were placed in teeth preparations Class I and Class II. Also, bitewing and or periapical radiographs were used to define the depth of the cavity. The data obtained were documented in a patient examination form then statistically analyzed using Chi-Square Test or Fisher-Freeman-Halton Test and Spearman's Correlation Coefficient.*

Results: *Composite was the predominant kind of restoration placed by dental interns, and dentists placed more composite restorations than amalgam ones. There was an insignificant relationship between the kind of restoration placed by dental interns (amalgam, composite) and the tooth type (maxillary / mandibular premolar, maxillary / mandibular molar), the class of tooth preparation, the cavity depth, the age of the patient, and the gender of the patient $p > 0.05$. However, there was a significant relationship between the kind of restoration placed by dentists (amalgam, composite) and the cavity depth $p < 0.05$. Also, dentists placed more composite restorations in maxillary first premolars and in young patients 8-29 years, while they placed more amalgam restorations in mandibular second molars and in older patients 41-50 years $p < 0.05$. There was an insignificant relationship between the kind of restoration placed by dentists (amalgam, composite) and the class of cavity preparation and the gender of the patient $p > 0.05$.*

Conclusion: *Both dentists and dental interns used composite restorative material more than amalgam, but dentists placed more amalgam restorations than dental interns. Dental interns mainly used composite.*

Keywords: *Amalgam, Composite, Class, Dentist, Depth, Intern, Type*

Introduction

Amalgam technically means an alloy of mercury (Hg) with any other metal. Dental amalgam is an alloy created by mixing mercury with a silver-tin dental amalgam alloy (Ag-Sn) and used as direct restorative material. In dentistry, the term amalgam commonly means dental amalgam. Varying amounts of copper (Cu) and small amounts of zinc (Zn) are

found to be added to an amalgam alloy. There are low-copper amalgam alloys and high-copper amalgam alloys. High-copper amalgam alloys show prominently better corrosion resistance than low-copper amalgam alloys. For use, amalgam is mixed by combining amalgam alloy particles with mercury, strenuously mixing the components (trituration) for a few seconds during the initial reaction, placing the mixture into a tooth preparation then condensing it to remove the excess mercury-rich phase, and finally carving and finishing the solidifying restoration.[1]

A composite is a physical mixture of materials,[1] and it is a globally used tooth-colored direct restorative material.[2] Composite consists of resin matrix (organic content), fillers (inorganic part), and coupling agents.[2] The filler particles are distributed within the matrix (fluid) phase.[1] The fillers are made of quartz, ceramic, and or silica.[2] The filler boosts the mechanical properties of the mixture and provides the enamel-like translucency to the material with the characteristics of light transmission and light scattering, while the matrix flows adapting into tooth preparation walls and penetrating into micromechanical spaces on etched enamel or dentin surfaces.[1,2]

The aim of this study was to detect the use of amalgam versus resin composite restorations placed in permanent posterior vital teeth among dentists practicing in Saudi Arabia and dental interns training in Saudi Arabia.

Materials and Methods

Ethical approval:

The study was registered with the research center of Riyadh Elm University (FRP/2019/123) and received ethical approval from the institutional review board of the same institution (RC/IRB/2019/237).

Selection of the content for analysis and statistical analysis

318 patients aged ≥ 8 years were randomly selected and clinically examined for amalgam and resin composite restorations placed in permanent posterior teeth with vital pulps (nonendodontically treated) by dentists and by dental interns in the Kingdom of Saudi Arabia. The study was carried out from October 2019 to February 2020. After taking the patient consent on an informed consent statement form for clinical studies, each patient was clinically examined in both the maxilla and the mandible for posterior composite and amalgam restorations placed in teeth preparations according to Black's classification[3]: Class I and Class II (mesio-occlusal MO, disto-occlusal DO, mesio-occluso-distal MOD). Also, bitewing and or periapical radiographs (radiographic examination) were used to define the depth of the cavity which was recorded based on the American Dental Association Caries Classification System (ADA CCS)[4]:

Initial: (E1, E2, D1) Radiolucency may extend to the dentinoenamel junction or outer one-third of the dentin

E1(excluded from the present study): Radiolucency extends into the outer half of the enamel[5]

E2 (excluded from the present study): Radiolucency extends into the inner half of the enamel[5]

D1 (included in the present study): Radiolucency extends into the outer one-third of the dentin[5]

Moderate:

D2 (included in the present study): Radiolucency extends into the middle one-third of the dentin

Advanced:

D3 (included in the present study): Radiolucency extends into the inner one-third of the dentin

Radiographs of D1, D2, and D3 are shown in Figure 1. Instead of radiolucency, radiopacity of the restoration was detected.

Posterior teeth were categorized into eight groups: maxillary first premolar, mandibular first premolar, maxillary second premolar, mandibular second premolar, maxillary first molar, mandibular first molar, maxillary second molar, mandibular second molar.

The data obtained including the age and the gender of the patient were documented in a patient examination form then statistically analyzed using Chi-Square Test or Fisher-Freeman-Halton Test when appropriate and Spearman's Correlation Coefficient to test the association between

categorical variables (restoration, age, gender, tooth type, cavity depth, class of tooth preparation, dental practitioner). All statistical analyses were performed using the IBM SPSS Statistics version 20 data processing software. The significance level was set at $p < 0.05$.

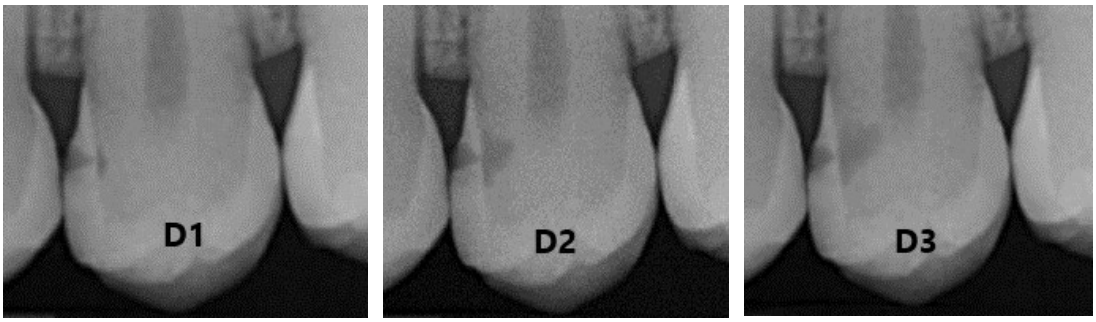


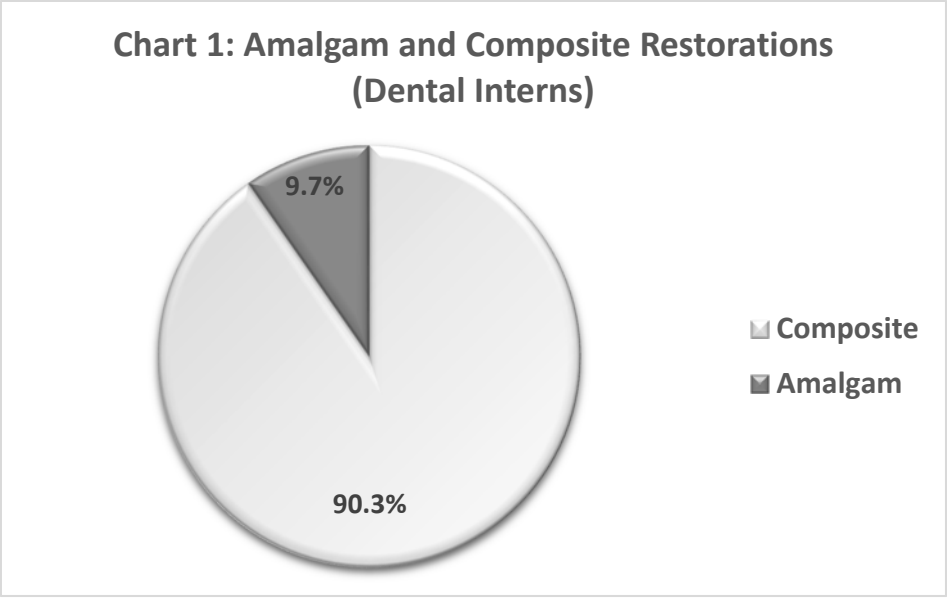
Figure 1. Radiographs D1, D2, D3 Lesions
Source: American Dental Association Caries Classification System, 2015[4]

Result

The sample of 318 patients consisted of males n =133 (41.8%) and females n = 185 (58.2%). The age groups were as the following: 8-29 years n = 143 (45%), 30-40 years n = 94 (29.6%), 41-50 years n =57 (17.9%), and ≥ 51 years n=24 (7.5%). The total number of restorations placed by dentists was n = 417, and it was n = 339 for those placed by dental interns.

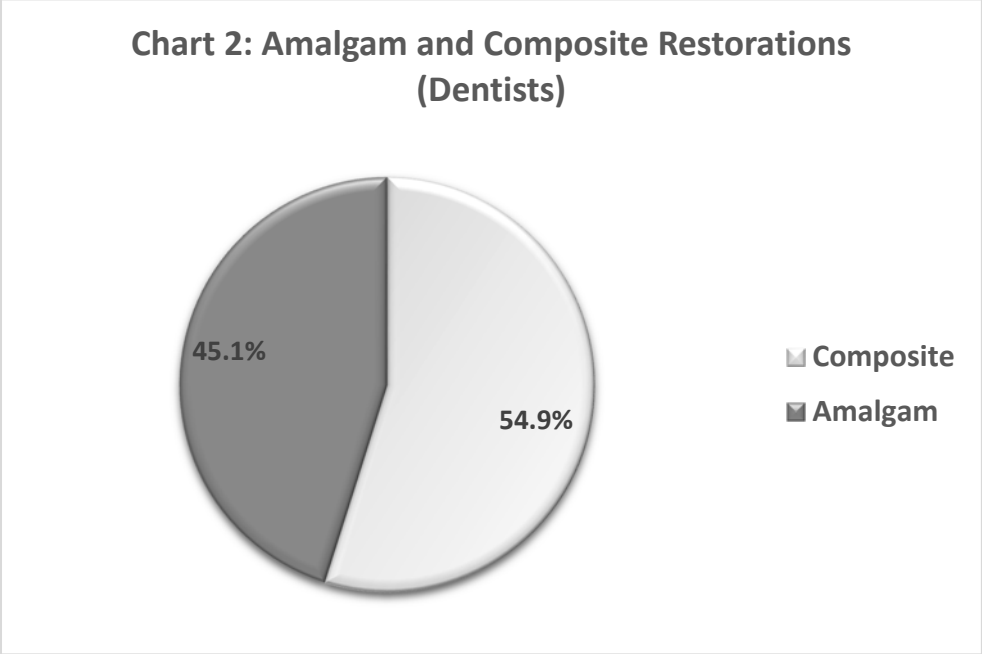
Type of Restoration (Amalgam and Composite) Dental Interns

Chi-Square Test showed that there was a significant difference in the percentages of dental restorations placed by dental interns (amalgam and composite) $p = 0.000 < 0.05$, and composite was the predominant kind of restoration placed by dental interns (Chart 1).



Dentists

Chi-Square Test showed that there was a significant difference in the percentages of dental restorations placed by dentists (amalgam and composite) $p = 0.045 < 0.05$, and composite restorations were placed more than amalgam restorations by dentists (Chart 2).



Restoration and Tooth Type

Dental Interns

Fisher's Exact Test showed that there was an insignificant relationship between the kind of restoration (amalgam, composite) placed by dental interns and the tooth type (maxillary first premolar, mandibular first premolar, maxillary second premolar, mandibular second premolar, maxillary first molar, mandibular first molar, maxillary second molar, mandibular second molar) $p = 0.443 > 0.05$.

Dentists

Chi Square Test showed that there was a significant relationship between the kind of restoration placed by dentists (amalgam, composite) and the tooth type (maxillary first premolar, mandibular first premolar, maxillary second premolar, mandibular second premolar, maxillary first molar, mandibular first molar, maxillary second molar, mandibular second molar) $p = 0.078 < 0.05$. The Contingency Coefficient value was 17.2% with $p = 0.078 < 0.05$. Composite restorations were placed more than amalgam restorations in maxillary first premolars (72.2%) and (27.8%), respectively. However, amalgam restorations were placed more than composite restorations in mandibular second molars (57.4%) and (42.6%), respectively.

Restoration and Class of Tooth Preparation Class I / Class II (MO, DO, MOD)

Dental Interns

Fisher's Exact Test showed that there was an insignificant relationship between the kind of restoration placed by dental interns (amalgam, composite) and the class of tooth preparation $p = 0.615 > 0.05$.

Dentists

Chi Square Test showed that there was an insignificant relationship between the kind of restoration placed by dentists (amalgam, composite) and the class of tooth preparation $p = 0.998 > 0.05$.

Restoration and Cavity Depth (D1, D2, D3)

Dental Interns

Chi Square Test showed that there was an insignificant relationship between the kind of restoration placed by dental interns (amalgam, composite) and the cavity depth (D1, D2, D3) $p = 0.189 > 0.05$.

Dentists

Chi Square Test showed that there was a significant relationship between the kind of restoration placed by dentists (amalgam, composite) and the cavity depth (D1, D2, D3) $p = 0.038 < 0.05$. The Contingency Coefficient value was 12.4% with $p = 0.038 < 0.05$. Composite restorations were placed more than amalgam restorations in the cavity depth D1 (64.1%) and (35.9%), respectively.

Restoration and Patient's Age

Dental Interns

Spearman's Correlation Coefficient showed that there was an insignificant relationship between the kind of restoration placed by dental interns (amalgam, composite) and the age of the patient $p = 0.176 > 0.05$.

Dentists

Chi Square Test showed that there was a significant relationship between the kind of restoration placed by dentists (amalgam, composite) and the age of the patient $p = 0.000 < 0.05$. The Contingency Coefficient value was 22.5% with $p = 0.000 < 0.05$. Composite restorations were placed more than amalgam restorations in young patients aged 8-29 years (69.2%) and (30.8%), respectively. However, amalgam restorations were placed more than composite restorations in older patients aged 41-50 years (61.1%) and (38.9%), respectively.

Restoration and Patient's Gender

Dental Interns

Chi-Square Test showed that there was an insignificant relationship between the kind of restoration placed by dental interns (amalgam, composite) and the gender of the patient (male, female) $p = 0.069 > 0.05$.

Dentists

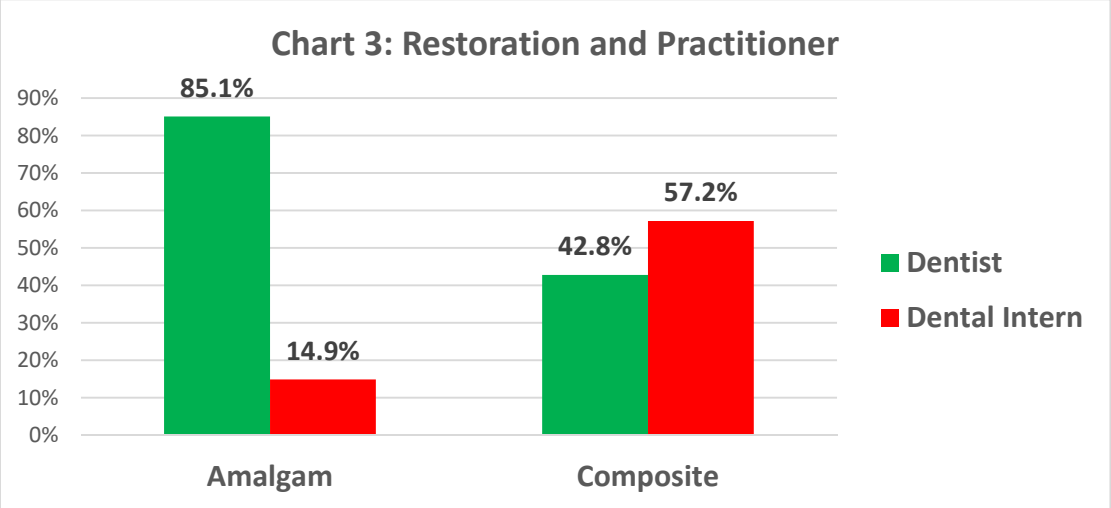
Chi-Square Test showed that there was an insignificant relationship between the kind of restoration placed by dentists (amalgam, composite) and the gender of the patient (male, female) $p = 0.625 > 0.05$.

Restoration and Dental Practitioner

Chi Square Test showed that there was a significant relationship between the kind of restoration (amalgam, composite) and the dental practitioner (dentist, dental intern) $p = 0.000 < 0.05$. Phi Coefficient value was 38.7% with $p = 0.000 < 0.05$ and Cramer's V Coefficient value was 38.7% with $p = 0.000 < 0.05$. Dentists placed more amalgam restorations than dental interns (85.1%) and (14.9%), respectively. However, dental interns placed more composite restorations than dentists (57.2%) and (42.8%), respectively (Table 1, Chart 3).

Table 1: Restoration and Dental Practitioner

Restoration		Practitioner		Total
		Dentist	Dental Intern	
Amalgam	n (%)	188 (85.1)	33 (14.9)	221 (100)
Composite	n (%)	229 (42.8)	306 (57.2)	535 (100)
Total	n (%)	417 (55.2)	339 (44.8)	756 (100)



Discussion

The most frequent reason for replacement of amalgam and composite restoration is secondary caries.[6-12] However, many studies indicated that permanent posterior teeth restored with resin composite presented higher risk of secondary caries compared with those restored with amalgam.[7,8,10,13] For instance, in the United Kingdom, the majority of the general dental practitioners, 87% for composite and 91% for amalgam, reported that secondary caries was the main reason for replacement of amalgam and composite restorations.[7] In the same context, Bernardo et al[8] found that secondary caries was the main reason for failure in both posterior composite and amalgam restorations, but risk of secondary caries was 3.5 times higher in composite restorations. Also, in their review study, Rasines Alcaraz et al[10] indicated that, in permanent posterior teeth, resin composite had an increased risk of secondary caries when compared with amalgam restorations (risk ratio (RR) 2.14, 95% confidence interval (CI) 1.67 to 2.74). In addition, Moraschini et al[13] concluded that, in posterior teeth, resin composite restorations had a higher number of secondary caries when compared with amalgam restorations. According to Opdam et al,[11] the main reasons for the failure of posterior resin composite restorations were caries and fracture, and Burke et al[6] found that the main reason for the replacement of amalgam and composite restorations was secondary caries, followed by fracture. Also, Bernardo et al[8] found that all posterior composite and amalgam restorations failed because of secondary caries, followed by fracture, but there was no statistically significant difference between the two restorative materials in relation to fracture. In the same context, Moraschini et al[13] found that, in posterior teeth, there was no statistically significant difference between amalgam and resin composite regarding the time of follow-up with respect to fracture, and Rasines Alcaraz et al[10] found that posterior resin composite restorations didn't show an increased risk of restoration fracture compared with posterior amalgam restorations (RR 0.87, 95% CI 0.46 to 1.64).

With respect to the survival rate, many studies agree that amalgam has a higher survival rate than resin composite. For instance, Burke et al[6] concluded that amalgam presented greater longevity than composite. Also, Bernardo et al[8] found that the survival rate of posterior amalgam restorations at seven years was 94.4%, and it was 85.5% for posterior composite restorations; mean annual failure rates ranged from 0.16 to 2.83 percent for amalgam restorations and from 0.94 to 9.43 percent for composite restorations.[8] In addition, Rasines Alcaraz et al[10] concluded that posterior resin composite restorations had a significantly higher risk of failure than amalgam restorations (risk ratio (RR) 1.89, 95% confidence interval (CI) 1.52 to 2.35), and Levin et al[12] observed higher failure rates in resin-based composite restorations than in amalgam restorations in posterior interproximal restorations. Furthermore, Forss and Widström[14] found that the median ages of failed restorations were nearly 12 years for amalgam and slightly less than 5 years for composite. In the same context, Moraschini et al[13] suggested that resin composite restorations in posterior teeth still have less longevity, and De Moor and Delmé[15] mentioned that, in posterior teeth, the survival of dental amalgam fillings is two times higher than composite fillings. Moreover, Hickel and Manhart[9] found that the annual failure rate in posterior stress-bearing restorations is 0%-7% for amalgam and 0%-9% for direct composite.

The cavity depth and the number of surfaces of a restoration are predictors of subsequent restoration failure. For instance, McCracken et al[16] found that Odds of failure for deeper restorations were about 60 percent greater than those for shallower restorations, and failure rate increased with an increase in the number of surfaces of a restoration. Also, Bernardo et al[8] concluded that the difference in performance of posterior composite and amalgam restorations was prominent in large restorations and in those that involved more than three surfaces, and they implicated that if longevity is the essential criterion in material selection, it's better to use amalgam in multi-surface restorations of large posterior teeth than composite. Also, dental

practitioners are advised to place resin composite restorations only in small to moderately sized cavities because despite of developed manufacturing, composite restorations placed in occlusal load-bearing are technically much more demanding than amalgam and may not maintain occlusal contacts as well. [17] In addition, although composite restorations have acceptable wear features in small cavities, loss may be seen in larger cavities surface within approximately five years; occlusion and late effects of polymerization shrinkage may result in marginal breakdown of composite restorations.[17] Furthermore, Gholampour et al[18] detected the effect of dental filling material and filling depth on the strength and deformation of filled teeth; the analyses were performed in two filling depths of 1/2 and 1/3 of the tooth height. They found that a 16.7% difference in filling depth led to a 8.9% stress difference in the first molar filled with composite, while the effect of depth on the level of stress in the tooth filled with amalgam was not considerable. For composite fillings, the amount of tooth deformation increased in the first molar for the filling depths 1/2 and 1/3 of the tooth height, but it was small for amalgam fillings in both filling depths. The first molar restored with amalgam was almost as strong as a normal tooth, whereas it was 13.7% weaker than the normal tooth when it was restored with composite. Gholampour and colleagues concluded that amalgam was a more suitable dental restorative material for the first molar although a 16.7% change in drilling depth is needed for tooth preparation.[18]

In the United Kingdom, Burke et al[7] found that 49% of dentists rarely or never place large composite restorations in molar teeth; the dentists responded that their choice of the restorative material is influenced to a great extent by clinical indications and patients' esthetic demands. Burke et al[7] concluded that composite was not used in load-bearing situations for the following reasons: "perceived poorer wear resistance than amalgam, perceived difficulties in manipulation, less good value for money for the patient, increased number of symptoms with composite, more time-consuming placement, and, perceived reduced longevity."[7]

In Brazil, Parolo et al[19] found that a higher number of amalgam restorations was placed in posterior teeth in public health service in comparison to two dental schools (Federal University of Rio Grande do Sul and Lutheran University of Brazil) where composite resin restorations dominated; they concluded that the Public Health Dental System widely used amalgam in posterior teeth, while dental schools were changing from amalgam towards placing composite in posterior teeth. Also, in Brazil, Terada et al[20] found that the majority of restorations were placed with amalgam in 10 basic health units, while there was higher prevalence of resin composite restorations at a public dental school. In addition, in the United States, Canada, the United Kingdom, and Ireland, there has been an inclination towards increasing the teaching of posterior composites in recent years.[21] Furthermore, in Saudi Arabia, Pani et al[22] found that a substantial number of undergraduate students regardless of the type of school chose posterior resin composite over amalgam. Students in both the private and the government college were likely to give higher scores for composite than amalgam. Despite the fact that the majority of students in both schools felt that amalgam could not be completely replaced by composite, a greater number of students in the private school felt that amalgam would be replaced by composite resin restorations. The dental students believed that the main drawback of amalgam was lack of esthetics, whereas it was micro-leakage for composite.

The present study found that both dentists and dental interns used composite more than amalgam; however, dentists placed more amalgam restorations than dental interns, and dental interns mainly used composite. These findings are consistent with those of Alkhudhairy[23] study which targeted Saudi dentists and dental interns working in both private and public sectors in Riyadh, Saudi Arabia. Alkhudhairy[23] found that compared with dentists, a significantly greater number of dental interns did not use amalgam in their clinical practice frequently, agreed on replacing a good amalgam restoration with resin composite, and on ceasing the use of amalgam as a final restoration. Alkhudhairy[23]

concluded that dental amalgam is less frequently used among Saudi dentists and dental interns working in Riyadh; however, in comparison to experienced dentists fresh dental graduates used amalgam less frequently in Riyadh, Saudi Arabia. Esthetics was the reason for the majority of interns 76.1% and dentists 78.7% for restricting the use of dental amalgam. Also, McCracken et al[16] found that the age of the patient is a significant predictor to restoration failure; older patients presented higher failure. This finding may justify the results of the present study that showed that the age of the patient was related to the kind of restoration placed by dentists. In addition, in Saudi Arabia, Al-Safadi et al[24] found that undergraduate dental students mainly used resin composite in permanent posterior vital teeth regardless of the cavity depth, class of tooth preparation, tooth type, patient's age, and patient's gender which may justify the findings of the present study with respect to dental interns.

Conclusion

The results of this study indicated that both dentists and dental interns used composite restorative material more than amalgam in permanent posterior vital teeth (premolars, molars). However, dentists placed more amalgam restorations than dental interns, while dental interns placed more composite restorations than dentists. Also, dental interns substantially placed composite restorations regardless of the tooth type, cavity depth, and patient's age; however, tooth type, cavity depth, and patient's age were related to the kind of restoration (amalgam, composite) placed by dentists. Both the gender of the patient and class of tooth preparation were not related to the kind of restoration (amalgam, composite) placed by dentists or dental interns.

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