Knowledge and Attitude of Recent Dental Graduates towards Smart/Bioactive Dental Composites

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors FH and HY designed the study. Author SK implemented the study and began statistical analysis. Author FH finalized statistical analysis. Author HY wrote first draft of manuscript. Author FH finalized manuscript. Authors HY and FH proofread the final manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The purpose of this study was to explore the knowledge and attitude of dental interns vs newly graduated dentists (NGD) towards recently introduced smart/bioactive dental resin composites (SDCs).

Study Design: Cross-sectional study.

Place and Duration of Study: Restorative Dentistry Department, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia from March 2018 to June 2018.

Methodology: An online questionnaire was distributed among randomly chosen interns and NGDs in multiple countries (n= 164). The questionnaire was formulated using Google Forms. Statistical analysis of the results was conducted using percentages and frequencies and compared using Chi-square test (P<0.05).

Results: 59.15% of all respondents expressed interest in perusing restorative dentistry as a specialty. A statistically significant lower proportion of NGDs compared to interns reported a good understanding of dental restorative materials (P=.022), hearing of SDCs (P=.033), or ever using SDCs (P=.006). 50% of NGDs reported thinking that SDCs effectively regenerate dental hard tissue.
was significantly (P=.016) lower than interns (70.5%). 97.6% of NGDs and 96.7% of interns reported willingness to attend a training workshop and/or a continuing education course about SDCs.

**Conclusion:** Interns showed a significantly higher positive attitude towards SDCs use. Knowledge and effective use of SDCs by interns and NGDs could be improved by more training such as that offered in workshops/courses.

**Keywords:** Survey; dental graduates; smart composites; bioactive materials; remineralization; restorative dentistry.

## 1. INTRODUCTION

According to the WHO, dental caries remains one of the most prevalent diseases around the world [1]. The carious process is a continuous process of multiple demineralization and remineralization cycles, which lead to localized dissolution of the tooth structure’s mineral phase when the equilibrium between the two processes is disturbed [2]. Dental resin composites are among the most commonly used materials to restore carious lesions in patients’ mouths. This is due to both the enhanced esthetic and physical properties of dental resin composites [3]. Despite their popularity, most of the currently available dental resin composites simply restore anatomical form and function to the defects created in the teeth without any further therapeutic value [4]. An estimated 40% of dental resin composite fillings need to be replaced within approximately 10 years of placement [5]. In theory, the longevity of restorations would be improved if restorative materials could remineralize tooth structure. Using a restorative material with the ability to eliminate the risk of further demineralization would help prevent secondary decay in restorations, which remains one of the main causes of restorative failure [6,7].

Dentists globally are moving towards the utilization of remineralization techniques and conservative restorative treatments [8,9]. The remineralization process simply involves the dissemination of both calcium and phosphate from multiple sources; saliva as well as topical products accelerated in the presence of fluoride to create a hyper-mineralized acid-resistant coating on existing crystal remnants [2]. Bioactive dental resin composite materials, which release ions to neutralize biofilm bacterial acids as well as to remineralize tooth structure are a relatively recent addition to the dental marketplace [10]. These materials are also known as “smart materials” as they are responsive to their external environment.

According to McCabe et al. [11], smart materials can be defined as “materials with properties which may be altered in a controlled fashion by stimuli, such as stress, temperature, moisture, pH, electric or magnetic fields”. Based on the above definitions, the terms ‘smart’ and ‘bioactive’ may be used interchangeably in relation to dental resin composites. Thus, these materials will be referred to as smart/bioactive dental resin composites (SDCs) in this work.

Several studies investigated the effectiveness of dental bioactive restorative materials and found them clinically effective [4,12,13]. They are used in conservative dentistry to regenerate, repair and reconstruct dental hard tissue by inducing the formation of hydroxyapatite, thus making these materials more therapeutic than their predecessors. There are several SDCs currently available in the market. Examples include: Cention N (Ivoclar Vivodent), Biodentine ® (Septodont), Beautifil (Shofu), and Activa ™ (Pulpdent).

To optimize the effect of such materials and provide patients with a potentially better outcome, clinicians must use them effectively in their practices. Materials are only fully utilized in practice when clinicians understand their properties, advantages, and disadvantages, thus becoming comfortable using them. As SDCs are a fairly recently introduced material, there is limited information in the literature regarding its use and teaching in undergraduate dental programs worldwide [14]. This study aims to look at the attitude of newly graduated dentists (NGDs) about SDCs, thus giving an impression regarding the likelihood of their usage in clinical practice.

## 2. MATERIALS AND METHODS

Ethical approval was obtained from King Abdulaziz university’s research ethics committee prior to commencement of the work. The ethical approval number is 060-02-19. This cross-
sectional study was conducted using an online questionnaire that was slightly modified from a validated questionnaire used in a previously published study [15]. The questions were modified to target knowledge, attitude and opinion of dental practitioners regarding SDCs. The questionnaire was formulated into a Google forms survey consisting of a total of 19 questions; 15 of which were in multiple choice question (MCQ) format, while the remaining 4 were formulated in a free response format (Fig. 1).

Fig. 1. Google Form survey questions used in the study
The survey questions were checked to establish face validity and then distributed amongst a random sample of dental students to ensure the practicability, reliability, validity, and analysis of responses. The Google Forms questionnaire was sent by email to 200 randomly selected newly graduated dentists and dental interns in multiple countries. The distributed survey ensured anonymity and confidentiality of the participants by requiring no identity-revealing information to be disclosed. Participation in the survey was completely voluntary, which was stated both in the invitation email as well as in the introductory text in the Google form. The survey questions addressed the demographic and biographic characteristics of the respondents, their role in dental practice, whether they’d heard of SDCs and if they have used any of them previously, as well as their opinion regarding their use and effectiveness. It also included questions addressing the respondents’ interest in restorative dentistry in general and pursuing further information and attending continuing education courses regarding SDCs. The time needed to respond to the survey question was estimated to be approximately 5 minutes. A reminder email was sent at the end of the second week of the study to non-respondents to encourage their participation in case they have missed the first email. The recorded responses were received within three weeks and the data collected was entered into a Microsoft Excel spreadsheet (n=164).

Statistical analysis of the results was conducted using SPSS computer software (Statistical Package for the Social Sciences, version 19.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated for the received responses received and Crosstab tables were created. Responses were presented as frequencies and percentages. Chi square statistical test was performed to compare the interns’ and newly graduated dentist’s (NGD) responses to the survey questions at a significance level ($P < .05$).

### 3. RESULTS AND DISCUSSION

#### 3.1 Results

A total of 164 responses were received during a 3-week period: 122 dental interns and 42 NGDs. This represented a total response rate of 82%. The results were analyzed statistically, and responses were presented as frequencies and Percentages as shown in Table 1.

| Table 1. Shows the Google Forms questions and their respective responses as frequencies and percentages |
| --- |
| **Would you consider specializing in restorative dentistry after you graduate?** | **Do you consider yourself to have a good understanding of different restorative materials available in the market?** |
| Frequency | Percent | Frequency | Percent |
| No | 67 | 40.85% | No | 28 | 17.07% |
| Yes | 97 | 59.15% | Yes | 136 | 82.93% |
| **Have you ever heard of bioactive dental resin composites?** | If yes, how did you hear about them? |
| Frequency | Percent | Frequency | Percent |
| No | 56 | 34.15% | Articles | 35 | 21.34% |
| Yes | 108 | 65.85% | Internet | 50 | 30.49% |
| Lectures | 23 | 14.02% |
| **Would you ever use bioactive dental resin composite?** | **Frequency** | **Percent** |
| No | 61 | 37.20% |
| Yes | 103 | 62.80% |
| **Have you ever used any type of bioactive dental resin composite materials in your practice?** | If so, which of the following: |
| Frequency | Percent | Frequency | Percent |
| No | 144 | 87.80% | Activa | 14 | 8.54% |
| Yes | 20 | 12.20% | Biodentine | 4 | 2.44% |
| Cention N | 2 | 1.22% |
Would you consider specializing in restorative dentistry after you graduate?

Do you use any type of bioactive dental resin composite materials in your practice?

Do you think that bioactive composites effectively regenerate dental hard tissue?

Do you think bioactive dental resin composites are better than the conventional dental resin composites?

The total responding participants were made up of 84 males and 80 females: 122 NGDs and 42 interns. The mean age of respondents was 25.5 years old (Fig. 2).

The proportion of NGDs (71.4%) considering specializing in restorative dentistry was higher than interns (54.9%). However, the difference was statistically insignificant ($P = .06$) (Table 2).

The proportion of NGDs (71.4%) that reported having a good understanding of different restorative materials available in the market was statistically significantly lower than interns ($P = .02$) (Table 3).

The proportion of NGDs (52.4%) who had heard about SDCs was statistically significantly lower than interns ($P = .03$) (Table 4).

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**Fig. 2.** Shows the respondent’s demographic data

A: Pie-chart representing the males and females’ proportion of respondents, B: Pie-chart representing the proportion of interns and NGDs responding to the questionnaire, C: Bar-chart representing the age distribution of the respondents
Table 2. Shows the statistical Chi-squares test comparison between NGDs and interns for reported interest in specializing in restorative dentistry

| Would you consider specializing in restorative dentistry after you graduate? | Total | Chi Squared | P-Value |
|---|---|---|---|
| No | Yes | | |
| Interns | 55 | 67 | 122 | 3.53 | 0.06 |
| 45.1% | 54.9% | 100.0% | 42 |
| NGDs | 12 | 30 | 42 | 100.0% |
| 28.6% | 71.4% | 100.0% |
| Total | 67 | 97 | 164 |
| 40.9% | 59.1% | 100.0% |

Table 3. Shows the Chi-square test results for the responses regarding having a good understanding of different restorative materials

| Do you consider yourself to have a good understanding of different restorative materials available in the market? | Total | Chi Squared | P-Value |
|---|---|---|---|
| No | Yes | | |
| Interns | 16 | 106 | 122 | 5.27 | 0.02 |
| 13.1% | 86.9% | 100.0% | 42 |
| NGDs | 12 | 30 | 42 |
| 28.6% | 71.4% | 100.0% |
| Total | 28 | 136 | 164 |
| 17.1% | 82.9% | 100.0% |

Table 4. Shows the tabulated Chi-square test results for the reported previous knowledge of bioactive dental resin composites

| Have you ever heard of bioactive dental resin composites? | Total | Chi Squared | P-value |
|---|---|---|---|
| No | Yes | | |
| Interns | 36 | 86 | 122 | 4.56 | 0.033 |
| 29.5% | 70.5% | 100.0% | 22 |
| NGDs | 20 | 22 | 42 |
| 47.6% | 52.4% | 100.0% |
| Total | 56 | 108 | 164 |
| 34.1% | 65.9% | 100.0% |

Table 5. Shows the tabulated Chi-square test results for the responses regarding the method of hearing about SDCs

| If yes, how did you hear about them? | Total | Chi Squared | P-value |
|---|---|---|---|
| Articles | Internet | Lectures | | |
| Interns | 31 | 37 | 18 | 86 | 2.73 | 0.256 |
| 36.0% | 43.0% | 20.9% | 100.0% |
| NGDs | 4 | 13 | 5 | 22 |
| 18.2% | 59.1% | 22.7% | 100.0% |
| Total | 35 | 50 | 23 | 108 |
| 32.4% | 46.3% | 21.3% | 100.0% |

The difference between the proportion of NGDs and interns regarding the method they heard about the SDCs; articles, internet, or lectures was not statistically significant ($P= 0.256$) (Table 5). The proportion of NGDs (45.2%) that would ever use SDCs was lower than interns (68.9%). The difference was highly statistically significant ($P<0.01$) (Table 6).
The proportion of NGDs (4.8%) reporting to ever have used SDCs in their practice was lower than interns (14.8%). However, the difference was not statistically significant ($P=0.09$) (Table 7).

The proportion of NGDs (0%) that reported use of any type of SDCs in their practice was lower than interns (12.3%). The difference was statistically significant ($P=0.017$) (Table 8).

The proportion of NGDs (50%) that reported thinking that SDCs effectively regenerate dental hard tissue was lower than interns (70.5%). The difference was statistically significant ($P=0.016$) (Table 9).

Almost all NGDs and interns reported that they are willing to attend a training workshop and/or a continuing education course about SDCs in restorative dentistry. There was no statistically significant difference between NGDs and interns regarding that question ($P=0.77$) (Table 10).

### Table 6. Shows the tabulated Chi-square test results for the responses regarding ever using SDCs

| Would you ever use bioactive dental resin composite? | Total | Chi Squared | P-Value |
|-----------------------------------------------------|-------|-------------|---------|
| No                                                  | Yes   |             |         |
| Interns                                             |       |             |         |
| 38                                                  | 84    | 122         | 7.46    | 0.006  |
| 31.1%                                               | 68.9% | 100.0%      |         |
| NGDs                                                |       |             |         |
| 23                                                  | 19    | 42          |         |
| 54.8%                                               | 45.2% | 100.0%      |         |
| Total                                               |       |             | 100.0%  |
| 61                                                  | 103   | 164         |         |
| 37.2%                                               | 62.8% | 100.0%      |         |

### Table 7. Shows the tabulated Chi-square test results of the responses regarding previous use of SDCs by the respondents

| Have you ever used any type of bioactive dental resin composite materials in your practice? | Total | Chi Squared | P-Value |
|----------------------------------------------------------------------------------------|-------|-------------|---------|
| No                                      | Yes   |             |         |
| Interns                                 |       |             |         |
| 104                                     | 18    | 122         | 2.91    | 0.088  |
| 85.2%                                   | 14.8% | 100.0%      |         |
| NGDs                                    |       |             |         |
| 40                                      | 2     | 42          |         |
| 95.2%                                   | 4.8%  | 100.0%      |         |
| Total                                   |       |             | 100.0%  |
| 144                                     | 20    | 164         |         |
| 87.8%                                   | 12.2% | 100.0%      |         |

### Table 8. Shows the tabulated Chi-square results for the reported current use of SDCs in the respondents’ practice

| Do you use any type of bioactive dental resin composite materials in your practice? | Total | Chi Squared | P-Value |
|-----------------------------------------------------------------------------------|-------|-------------|---------|
| No                                   | Yes   |             |         |
| Interns                             |       |             |         |
| 107                                  | 15    | 122         | 5.68    | 0.017  |
| 87.7%                               | 12.3% | 100.0%      |         |
| NGDs                                |       |             |         |
| 42                                   | 0     | 42          |         |
| 100.0%                              | 0.0%  | 100.0%      |         |
| Total                               |       |             | 100.0%  |
| 149                                  | 15    | 164         |         |
| 90.9%                               | 9.1%  | 100.0%      |         |
Table 9. Shows the tabulated Chi-square results of the responses to whether SDCs effectively regenerate dental hard tissues

| Do you think that bioactive composites effectively regenerate dental hard tissue? | No  | Yes  | Total | Chi Squared | P-Value |
|----------------------------------|-----|------|-------|------------|---------|
| Interns                          | 36  | 86   | 122   | 5.79       | 0.016   |
|                                  | 29.5% | 70.5% | 100.0% |            |         |
| NGDs                             | 21  | 21   | 42    | 100.0%     |         |
|                                  | 50.0% | 50.0% |        |            |         |
| Total                            | 57  | 107  | 164   | 100.0%     |         |
|                                  | 34.8% | 65.2% |        |            |         |

Table 10. Shows the tabulated Chi-square analysis of the responses regarding the willingness of the respondents to attend educational courses regarding SDCs

| Would you be willing to attend a training workshop and/or a continuing education course about bioactive dental resin composite materials in restorative dentistry? | No | Yes | Total | Chi Squared | P-Value |
|------------------------------------------------------------------------------------------------|----|-----|-------|------------|---------|
| Interns                                                                                         | 4  | 118 | 122   | 0.09       | 0.77    |
|                                                                                                  | 3.3% | 96.7% | 100.0% |            |         |
| NGDs                                                                                           | 1  | 41  | 42    | 100.0%     |         |
|                                                                                                  | 2.4% | 97.6% |        |            |         |
| Total                                                                                          | 5  | 159 | 164   | 100.0%     |         |
|                                                                                                  | 3.0% | 97.0% |        |            |         |

3.2 Discussion

Composite resin materials are used for the restoration of both anterior and posterior teeth due to their esthetic and conservative characteristics, advantageous physical and mechanical properties, and relative affordability [15,16]. However, conventional composite resin restorative materials merely restore the dental structure that was lost due to caries rather than have any therapeutic effect. Secondary caries is notoriously known as the most commonly detected failure mode in composite resin restorations [17]. Recently, a new generation of SDCs has been introduced, with their focus being prevention of recurrence of dental caries and having a positive effect on caries-affected dental hard tissues [4,18]. Several approaches have been proposed to achieve this goal. Some materials incorporated calcium phosphate nanoparticles into their composition, while others release fluoride to inhibit the development of secondary caries and possibly arrest initial lesions [19,20]. Another group of SDCs work by suppressing biofilm growth, bacterial attachment and acid production leading to the inhibition of the caries process. thereby making it more difficult for bacteria to attach to the surface [4, 19,21,22].

Surveys are a widely used method of assessing the knowledge and attitudes of dentists, among other groups [23-25]. An acceptable response rate to questionnaires has been approximated at 64% [19]. This survey achieved a response rate of 80%, which is well beyond the suggested 64%. This cross-sectional survey study aimed at investigating the knowledge status and attitudes of NGDs and interns regarding SDRs. This would provide insight into the current status as well as the possibility of incorporating such materials in caries control clinical practices with more conservative reparative treatment modalities [26]. The results of this study showed that the proportion of NGDs (71.4%) considering specializing in restorative dentistry was almost statistically significantly (P=0.006) higher than interns (54.9%). However, the proportion of the total number of both NGDs and interns indicated they would like to specialize in restorative dentistry (total 59.1% of respondents). This result agrees with the findings from a study by Halawany et al that reported restorative and esthetic dentistry specialty was preferred by final-year dental students in Saudi Arabia [27]. Although the majority of respondents expressed their interest in restorative dentistry specialization, NGDs reported a significantly lower understanding of dental restorative
Hasanain et al.; JPRI, 33(32B): 34-44, 2021; Article no.JPRI.70020

materials ($P=.02$). This result contradicts the results reported by Saudi dentists in a previous study by Haider et al, where the longer clinical experience of dental practitioners compared to students and interns influenced the restorative materials knowledge [28]. This higher perceived knowledge of NGDs compared to interns and dental students was also noted in the choice of restorative material with, as reported by Barakah et al. [29].

As a result of self-reported lack of understanding of restorative dental materials in NGDs, significantly fewer NGDs reported ever hearing of smart/bioactive materials than dental interns ($P=.03$). This may be due to the fact that many dental interns are still in their respective academic institutions and attending workshops or seminars as part of their training, while NGDs are busier in their daily dental practices and may not be attending seminars regarding new restorative materials. Thus, the longer experience duration that NGDs had in this study didn't increase their reported knowledge of SDCs existence or their respective utilization in dental practice. A study by Nassar et al, reported a similar absence of clinical experience positive effect on the dentists' use of new bulk fill restorative resin materials [30].

Consequently, significantly fewer NGDs reported current use of SDCs in their practices ($P=.017$) or thinking that SDCs effectively regenerated dental hard tissues ($P=.016$). This result is similar to that from a study by Gomez et al, where it was found that Colombian dentists didn’t completely utilize non-invasive conservative smart materials in their practice to control caries [31]. In the current study, there was a significantly greater enthusiasm towards future use of SDCs from the interns when compared to NGDs ($P<.01$).

There was no significant difference in the method of hearing about SDCs between interns and NGDs ($P=0.26$). The internet was reported to be most frequently used by interns (43%) and NGDs (59.1%) compared to other educational resources. This higher preference to electronic resources utilization is in the agreement with what Saudi dentists in Riyadh, KSA, used when faced with uncertainty in evidence-based dentistry, as reported by Al Malki et al. [32]. However, the limited access to resources was a major obstacle to continuous education according to Fedorowicz et al. [33]. There was a greater enthusiasm towards SDCs from the interns when compared to NGDs.

Interestingly, the majority of both dental interns (96.7%) and NGDs (97.6%) reported being open to learning more about and potentially using SDCs but indicated a need for more training. This shows a willingness to learn about and try new dental materials/therapies from young dentists, which is a promising finding.

4. CONCLUSION

Younger dental practitioners are moving towards the application of remineralization restorative products when treating carious teeth as indicated by 11% of the surveyed interns using SDCs. Despite the low percentage found, the majority of both groups indicated a willingness to learn more about SDCs. Within the limitations of this study, the authors believe that, further training would increase the utilization of SDCs by dentists and ultimately benefit patients.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per King Abdulaziz University’s standard guideline, participants’ consent has been obtained and preserved by the authors.

ETHICAL APPROVAL

Ethical approval was obtained from King Abdulaziz University’s research ethics committee prior to commencement of the work. The ethical approval letter number is 060-02-19.

COMPETING INTERESTS

Authors have declared that no competing interests exist.
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