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Original Article

Predictors of procedural errors in class II resin composite restorations using bitewing radiographs

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ABSTRACT

Objective: To identify the potential factors that induce procedural errors during posterior proximal resin composite restorations placed by dental students.
Materials and Methods: This retrospective study evaluated 803 bitewing radiographs of posterior proximal resin composite restorations placed by dental students at Imam Abdulrahman bin Faisal University. Atypical radiographic signs of failure were screened, and different patient-, operator-, and clinical-related factors were recorded. Chi-square test was used to examine the relationship between procedural errors and recorded factors. Stepwise adjusted logistic regression model was performed to identify predictors of procedural errors.
Results: The most observed errors were internal gaps at the bonding interface and internal voids. Molars had 0.39 the risk of internal voids (odds ratio [OR] = 0.39; confidence interval [CI] = 0.25–0.60; $P = <0.0001$), 0.41 the risk of sharp angle (OR = 0.41; CI = 0.24–0.68; $P = <0.001$), and 0.57 the risk of open contact (OR = 0.57; CI = 0.34–0.97; $P = 0.04$) compared to premolars. Those who were >40 years of age had 1.79 the risk of overhang compared to younger patients (OR = 1.79; CI = 1.04–3.11; $P = <0.04$). First molars and premolars had 0.64 the risk of overhang compared to second molars and premolars (OR = 0.64; CI = 0.41–1.00; $P = 0.04$). Junior students had 1.97 the risk of internal gap compared to their senior counterparts (OR = 1.97; CI = 1.20–3.21; $P = 0.008$). Mesial restorations had 0.38 the risk of external gap compared to mesio-occluso-distal (MOD) restorations (OR = 0.38; CI = 0.19–0.78; $P = 0.003$). Restorations with a margin coronal to the cemento-enamel junction (CEJ) had 0.44 the risk of external gap compared to those restorations with a margin apical to the CEJ (OR = 0.44; CI = 0.29–0.66; $P = <0.0001$).
Conclusion: Our findings suggested a higher incidence of procedural errors in restoring premolars and MOD cavity preparations. Therefore, it is crucial to enhance the comprehensiveness of laboratory training and expose students to diverse clinical scenarios and various techniques.

1. Introduction

Several studies have demonstrated a high failure rate of resin composite restorations (Balhaddad et al., 2019; Bhadila et al., 2023). Clinically, efficacious restorative treatment can be judged by the nonappearance of overhanging restorations and radiographic radiolucencies within and around the filling (Brouwer et al., 2016; Hayashi et al., 2017). The radiographic appearance of procedural errors such as marginal discrepancies, voids, overhang, and lack of internal adaptation indicate possible future clinical failure (Brouwer et al., 2016; Hayashi et al., 2017). The failure may involve the mechanical and biological aspects of the restoration, such as restoration's fracture and secondary caries (Ástvaldsdóttir et al., 2015; Opdam et al., 2014).

Several studies worldwide have investigated the clinical performance of resin composite proximal restorations placed by dental students. A study conducted at the Dental School of Nijmegen University,

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including 421 tested restorations, found that the survival rate of resin composite restorations was approximately 87% at 5 years, with secondary caries being the primary cause of failure (Opdam et al., 2004). Another study from Lutheran University in Brazil displayed a 72.10% survival rate over three years (Moura et al., 2011). In Saudi Arabia, among 1514 tested permanent teeth restored, 935 teeth revealed signs of failure, with overhanging restorations being the most observed failure (AlOtaibi et al., 2020).

The current evidence related to this topic did not investigate the association between certain clinical factors and the detected procedural errors in class II resin composite restorations. Identifying the clinical factors contributing to clinical failure may allow clinicians to pay more attention to such clinical scenarios and help clinical instructors improve their teaching methods when educating dental students. Therefore, this study aimed to (1) evaluate the prevalence of procedural errors in class II resin composite restorations placed by undergraduate dental students at Imam Abdulrahman bin Faisal University (IAU) and (2) identify the relation between certain clinical factors and the onset of such errors.

2. Materials and methods

2.1. Sample size calculation

Sample size analysis was computed using G*Power 3.1.5 software. Using two-tail logistic regression, a sample size of >749 was calculated to detect a risk ratio of at least 1.2 with a significance level of 95% and 80% power to predict procedural errors associated with clinical factors, assuming that there is a 5% difference between predictor levels.

2.2. Study design

This study was approved by the Institutional Review Board of IAU (IRB-2023–02-298). We retrospectively evaluated 803 bitewing x-rays in the IAU medical records to monitor proximal defective resin composite restorations in posterior teeth placed by dental students between January 2018 and June 2023. After obtaining the ethical approval, the electronic records were utilized to extract the bitewing x-rays, and data were transferred to an Excel file (Microsoft, Redmond, WA, USA). The study followed the guidelines for reporting observational studies in epidemiology (STROBE) when conducting the research (von Elm et al., 2007).

2.3. Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) Bitewing x-rays taken between January 2018 and June 2023 for proximal resin composite restorations accomplished by dental students, (2) x-rays taken at IAU, and (3) adult patients. The exclusion criteria were as follows: (1) Poor-quality images; (2) proximal restorations with no adjacent tooth; and (3) images with superimpositions from cervical restorations, orthodontic brackets, or fixed prostheses.

2.4. Radiographic assessment of the findings

Reliability tests to assess the intra-examiner reproducibility between two investigators (N.A. & M.A.) were performed. Then, the prevalence of class II procedural errors (Table 1) among dental students was quantified. The association between the screened procedural errors and patient-, operator-, and clinical-related factors was investigated. Patient-related factors included patient age at two levels (18–40 years and > 40 years), patient gender at two levels (male and female), and patient nationality at two levels (citizen and non-citizen). The operator-related factors included undergraduate year at three levels (4th, 5th, and 6th year) and student gender at two levels (male and female). Finally, the investigated clinical-related factors included tooth location at two levels (upper and lower arch), restored tooth at two levels (premolars and molars), tooth number at two levels (first and second), restored surfaced at three levels (mesial, distal, and mesio-occluso-distal [MOD]), marginal depth at two levels (coronal and apical to the cementoenamel junction [CEJ]), proximity to the pulp at three levels (outer dentin, inner dentin, and in between), and adjacent condition at four levels (sound, restored by another operator, decayed, and back-to-back performed by the same operator). Data were de-identified before data analysis to ensure confidentiality.

Table 1
List of procedural errors in class II resin composite restorations screened in this study.

Name of the Error	Description
Internal void	Circular radiolucency at the body of the restoration
Interlayer line	Thin radiolucent area between the restoration's layers
Overhang	Excess resin composite material interproximally
Radiographic open contact	Obvious open contact between the restored tooth and the adjacent
Internal gap at the bonding interface	Radiolucent area between the tooth and the restoration without the involvement of the gingival margin
External gap at the bonding interface	Radiolucent area between the tooth and the restoration with the involvement of the gingival margin
Remaining caries	Non-uniform radiolucency between the tooth and the restoration
Sharp angle	The proximal contour of the restoration is in sharp angle and not following the normal curvature of natural teeth

2.5. Statistical analysis

Chi-square test was used to examine the relationship between procedural errors and the reported factors. Stepwise adjusted logistic regression model was performed to identify predictors of procedural errors. All tests were two-sided, and the 0.05 level was used to indicate statistical significance. SAS 9.4 was used for statistical analysis.

3. Results

Intra-rater and inter-rater reliability for all outcomes measured were > 0.80 kappa statistics. Table 2 presents the demographic information of both the patients and operators and the characteristics of the teeth undergoing restoration. Fig. 1 illustrates the prevalence of procedural errors among the 803 patients included in the study. Of these patients, 280 (34.87%) had no class II resin composite procedural errors (Fig. 1A), 311 (38.73%) exhibited a single error, and 212 (26.40%) had multiple combined errors. Among the 311 patients with a single error (Fig. 1B), the most common errors were internal gaps at the bonding interface (19.61%) and internal voids (18.97%). Fig. 1C demonstrates the frequency of each error in all the screened resin composite restorations, regardless of whether they were categorized as single or combined errors.

Due to their limited sample size, 3rd-year dental students were excluded from the bivariate and multivariate analysis presented in Tables 3–5 ($n = 777$). Table 3 examines the impact of various patient-, and operator-related factors on procedural errors. Patients aged > 40 years were significantly more likely to exhibit external gaps at the bonding interface and overhangs compared to their younger counterparts ($P < 0.05$). Non-citizen patients were significantly ($P < 0.05$) more likely to experience overhangs, remaining caries, and open contacts. Internal gaps and remaining caries were more commonly observed among junior dental students ($P < 0.05$). Restorations with sharp angles were significantly more frequent among 5th-year dental students ($P < 0.05$). In terms of operator gender, female students were significantly more likely to inadvertently induce internal gaps at the bonding interface compared to their male counterparts.

Table 4 demonstrates the relationship between several clinical variables and procedural errors. The onset of internal voids was

Table 2
Characteristics and distribution of the variables investigated in this study.

Patient-related variables	n (%)
Patient Age	
18-40 years	586 (72.98)
>40 years	217 (27.02)
Patient Gender	
Male	404 (50.31)
Female	399 (49.69)
Nationality	
Citizen	606 (75.47)
Non-citizen	197 (24.53)
Operator-related variables	**n (%)**
Student Level	
3rd year	26 (3.24)
4th year	191 (23.79)
5th year	369 (45.95)
6th year	217 (27.02)
Student Gender	
Male	366 (45.58)
Female	437 (54.42)
Tooth-related variables	**n (%)**
Location	
Upper	425 (52.93)
Lower	378 (47.07)
Tooth	
Molar	315 (39.23)
Premolar	488 (60.77)
Tooth number	
First molar/premolar	424 (52.89)
Second molar/premolar	378 (47.07)
Third molar	1 (0.12)
Restored surface	
Mesial	321 (39.98)
Distal	429 (53.42)
MOD	53 (6.60)
Marginal depth	
Above cementoenamel junction	604 (75.22)
Below cementoenamel junction	199 (24.78)
Dentinal depth	
Outer Dentin	220 (27.40)
Inner Dentin	266 (33.13)
In between	317 (39.48)
Adjacent condition	
Sound	316 (39.35)
Restored by another operator	258 (32.13)
Restored by the same operator	157 (19.55)
Decayed	72 (8.97)

significantly associated with premolars and when back-to-back restorations were performed by the same operator ($P < 0.05$). Second molar and premolars are more likely to be associated with internal voids, overhang, and sharp angles restorations compared to first molars and premolars ($P < 0.05$). The occurrence of external gaps at the bonding interface was significantly associated with MOD resin composite restorations, deep restorations apical to the CEJ, and deep axial restorations close to the pulp ($P < 0.05$). Restorations with sharp angles on the proximal contour were significantly associated with upper teeth and premolars ($P < 0.05$), while open contact errors were predominantly observed among premolars ($P < 0.05$).

Table 5 illustrates the association between patient-, operator-, and clinical-related variables and the onset of class II resin composites' procedural errors. Molars had 0.39 the risk of internal voids (OR = 0.39; CI = 0.25–0.60; $P = <0.0001$) and 0.57 the risk of open contact (OR = 0.57; CI = 0.34–0.97; $P = 0.04$) compared to premolars. Those who were > 40 years of age had 1.79 the risk of overhang compared to those who were less than 40 years of age (OR = 1.79; CI = 1.04–3.11; $P = <0.04$). In addition, those who were citizens had 0.49 the risk of overhang compared to those who were non-citizens (OR = 0.49; CI = 0.31–0.79; $P = 0.003$). Furthermore, first molars and premolars had 0.64 the risk of overhang compared to second molars and premolars (OR = 0.64; CI = 0.41–1.00; $P = 0.04$). When using internal gap as an outcome, those students who were in their 4th year had 1.97 the risk of internal gap compared to those who were in their 6th year (OR = 1.97; CI = 1.20–3.21; $P = 0.008$). Mesial restorations had 0.38 the risk of external gap compared to MOD restorations (OR = 0.38; CI = 0.19–0.78; $P = 0.003$). In addition, restorations with a margin coronal to CEJ had 0.44 the risk of the external gap compared to those restorations with a margin apical to CEJ (OR = 0.44; CI = 0.29–0.66; $P = <0.0001$). When using sharp angle as an outcome, molars had 0.41 the risk of sharp angle compared to premolars (OR = 0.41; CI = 0.24–0.68; $P = <0.001$). First molars and premolars had 1.86 the risk of sharp angle compared to second molars and premolars (OR = 1.86; CI = 1.16–2.99; $P = 0.009$). Furthermore, 5th-year students had 3.17 the risk of sharp angle compared to 6th year students (OR = 3.17; CI = 1.72–5.82; $P = 0.0003$). Citizens had 0.49 the risk of remaining caries (OR = 0.49; CI = 0.27–0.93; $P = 0.03$) and 0.35 the risk of open contact (OR = 0.35; CI = 0.22–0.58; $P = <0.0001$).

4. Discussion

Our findings aligned with previous reports indicating that class II resin composite restorations were highly associated with atypical findings (AlOtaibi et al., 2020; Bazerbashi et al., 2023; Moura et al., 2011). A study conducted in the United States reported that 83.50% of proximal restorations were associated with procedural errors, with interfacial gaps and internal voids being the most frequent observations (Bazerbashi et al., 2023). Another study conducted in Saudi Arabia reported that 61.75% of the class II resin composite restorations were associated with atypical findings, with overhang and voids being recognized as the most common procedural errors (AlOtaibi et al., 2020). A failure rate of 72.10% was reported in Brazil when class II resin composite restorations achieved by dental students were evaluated (Moura et al., 2011). These findings suggest the need to improve laboratory training for dental students by exposing them to diverse clinical situations when restoring proximal restorations.

Internal voids were among the most common procedural errors in this study. Usually, voids result from air entrapment and improper packing during the placement of the restoration (Sarrett, 2005). The presence of voids within restorations has a detrimental effect on the material's flexural strength, resulting in reduced resistance to fatigue and wear (Kim et al., 2015; Kwon et al., 2014). We found that internal voids were significantly associated with premolars compared to molars and back-to-back restorations placed by the same operator. Another study also found that more void formation was associated with premolars than molars (Bazerbashi et al., 2023), suggesting that students tend to entrap air when they attempt to push large increments into the small proximal box in premolars. Dental students may tend to pack resin composite softly when restoring back-to-back class II preparation to avoid over-contouring their first restoration. These findings highlight the importance of implementing additional teaching tools to assist students in effectively managing such clinical situations.

Here, internal and external gaps at the bonding interface comprised 19.61% and 14.79%, respectively, of the single procedural errors. An increased number of gaps at the bonding interface may occur at the gingival floor due to moisture contamination caused by hydrostatic pulpal pressure and dentinal fluid flow following the etching process (Purk et al., 2007). To prevent the formation of gaps and enhance the bonding strength, it is important to replace any excess moisture on the dentin surface with the monomers found in the primer and adhesives during the bonding process (Perdigão et al., 2021). Besides, adhesives containing ethanol or acetone may perform better in wet environments because they can dislocate water and are more volatile (Purk et al., 2007). We found that cavities located more distally, closer to the pulp, and apically to the CEJ were more likely to exhibit an external gap at the bonding interface, highlighting the importance of training students in these scenarios during their laboratory sessions instead of only focusing

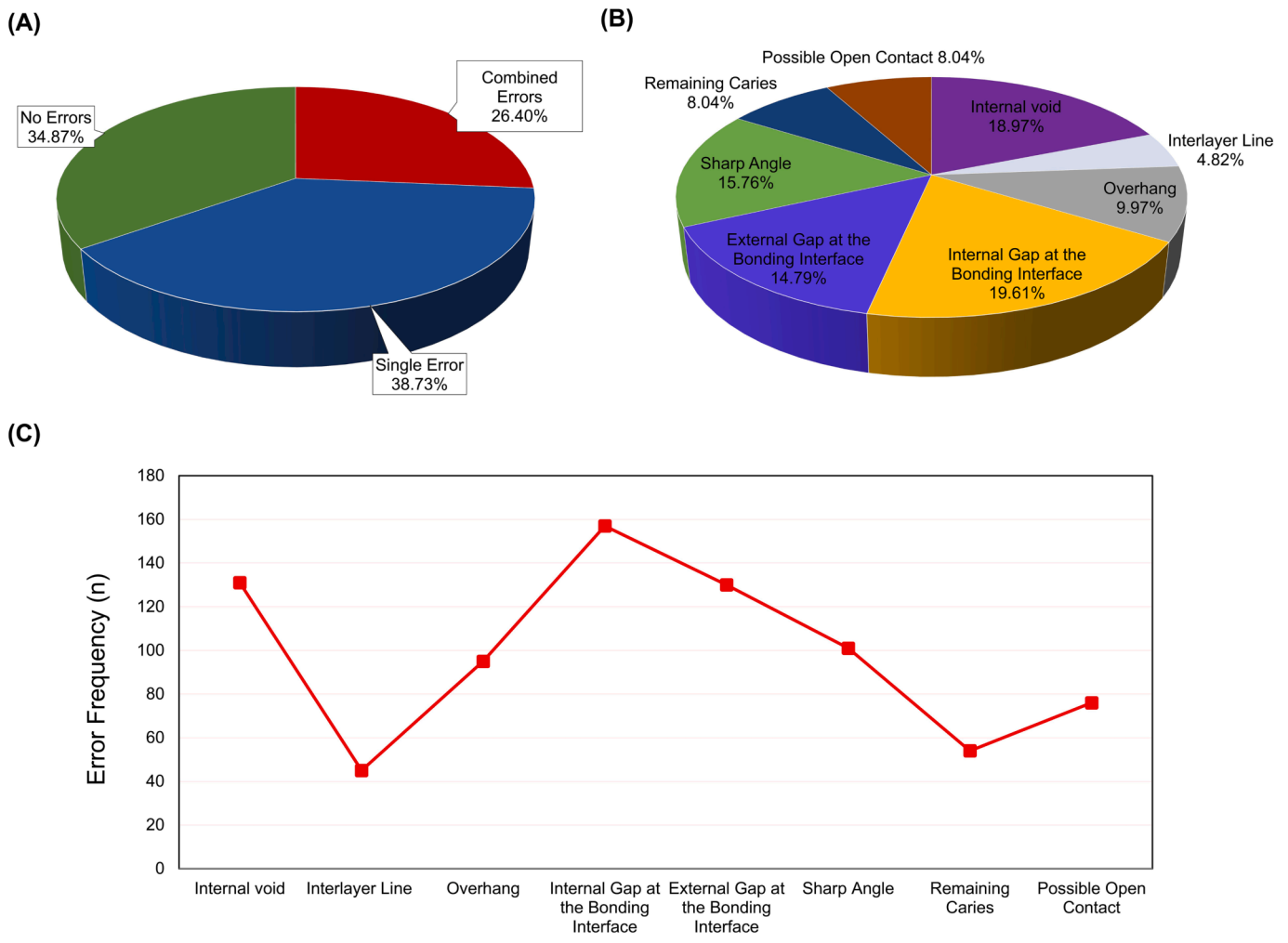

Fig. 1. Prevalence and characteristics of procedural errors in proximal resin composite restorations. (A) The general prevalence of radiographs with no, single, and combined errors. (B) The distribution of errors found in these radiographs with only one procedural error. (C) The frequency of all the procedural errors among the 803 screened radiographs, despite being observed as single or combined errors.

Table 3
Relationship between patient-, and operator-related factors and the included procedure errors. Data are described in percentage, and a strike indicates a significant difference ($P < 0.05$).

		Class II Resin Composite Procedural Errors							
		Internal Voids	Interlayer Line	Overhang	Internal Gap at the bonding interface	External Gap at the bonding interface	Sharp angle	Remaining Caries	Open Contact
Patient-related Factors									
Age	<40	16.89	4.95	**12.97***	19.45	**14.51***	13.82	7.00	9.22
	>40	14.75	7.37	**8.76***	19.82	**20.74***	9.22	5.99	10.14
Gender	Male	16.58	6.68	12.38	18.56	16.09	13.37	7.43	9.65
	Female	16.04	4.51	11.28	20.55	16.29	11.78	6.02	9.27
Nationality	Saudi	16.67	6.11	**10.07***	18.65	16.83	12.54	**5.28***	**7.10***
	Non-Saudi	15.23	4.06	**17.26***	22.34	14.21	12.69	**11.17***	**16.75***
Operator-related Factors									
Student Level	4th year	12.04	3.14	13.09	**26.18***	15.71	**10.99***	**6.28***	10.99
	5th year	19.24	6.50	10.30	**19.24***	17.62	**17.89***	**5.42***	8.13
	6th year	15.28	6.48	13.89	**15.28***	16.20	**6.48***	**6.02***	11.11
Student Gender	Male	15.57	6.56	10.93	**16.67***	15.30	12.57	7.10	8.47
	Female	16.93	4.81	12.59	**21.97***	16.93	12.59	6.41	10.30

Table 4
Relationship between clinical-related factors and the included procedure errors. Data were described in percentage, and a strike indicates a significant difference ($P < 0.05$).

		Class II Resin Composite Procedural Errors							
		Internal Voids	Interlayer Line	Overhang	Internal Gap at the bonding interface	External Gap at the bonding interface	Sharp angle	Remaining Caries	Open Contact
Tooth Location	Upper	14.82	5.18	11.06	17.41	16.47	**15.53***	6.59	8.71
	Lower	17.99	6.08	12.70	21.96	15.87	**9.26***	6.88	10.32
Tooth	Molar	**9.21***	6.03	11.43	17.46	13.33	**8.57***	7.30	**6.67***
	Premolar	**20.90***	5.33	12.09	20.90	18.03	**15.16***	6.35	**11.26***
Tooth Number	First	**12.74***	5.90	**9.43***	18.16	14.15	**13.68***	7.31	9.67
	Second	**20.37***	5.29	**14.55***	21.16	18.52	**11.11***	6.08	9.26
Surface	Mesial	13.08	5.61	13.08	20.25	**10.59***	11.53	6.85	8.10
	Distal	18.41	5.83	10.26	19.11	**18.88***	13.75	6.53	10.49
	MOD	18.87	3.77	16.98	18.87	**28.30***	9.43?	7.55	9.43
Margin depth	Coronal to CEJ	16.72	4.97	11.42	19.21	**12.58***	13.41	7.45	9.60
	Apical to CEJ	15.08	7.54	13.07	20.60	**27.14***	10.05	4.52	9.05
Depth to Dentin	Inner dentin	16.92	6.77	12.03	20.30	**20.68***	13.53	4.51	8.65
	In between	17.35	5.68	11.36	17.98	**14.20***	11.99	7.57	8.83
	Outer Dentin	14.09	4.09	12.27	20.91	**13.64***	12.27	8.18	11.36
Adjacent Condition	Sound	**14.87***	5.70	10.76	17.72	12.66	13.92	8.23	8.54
	Restored	**18.60***	5.81	13.18	22.09	18.99	10.47	4.65	10.85
	Decayed	**6.94***	2.78	13.89	19.44	20.83	15.28	6.49	4.17
	Back-to-back	**19.75***	6.37	10.83	19.11	16.56	12.10	7.01	11.46

Cemento-enamel junction (CEJ); mesio-occluso-distal (MOD).

on ideal class II cavity preparations during pre-clinical teaching.

Proper selection of the matrix system and the wedge size is essential to avoid sharp angles, overhang, and open contacts (Bailey et al., 2022; Lynch et al., 2018). For many years, circumferential matrix bands have been utilized to restore proximal missing walls (Bailey et al., 2022). While circumferential matrices provide good stabilizing capabilities cervically and coronally, making them beneficial in building heavily broken-down teeth, circumferential bands, unfortunately, are more prone to achieve restorations with light contact and sharp angles (Wirsching et al., 2011). To address these challenges, sectional matrices were developed with the aim of overcoming the limitations associated with circumferential matrix systems (Durr-E-Sadaf et al., 2018; Wirsching et al., 2011). Sectional matrices are usually used with a separating ring, which stabilizes the matrix coronally and helps achieve a good contact area (Durr-E-Sadaf et al., 2018; Wirsching et al., 2011). In addition, the size of the used wedge is essential. Using a wedge larger than needed will push the matrix toward the cavity, resulting in a deficient contour, leading to food impaction, gingival irritation, and secondary caries (Jackson, 2016). In this study, we observed that premolars were more likely to have sharp angles and open contacts compared to molars, suggesting that restoring small cavities is more challenging than larger ones.

Despite the ability of sectional matrices to achieve a good contact area, there is a considerable tendency not to use them because of their technique sensitivity (Bailey et al., 2022). For instance, some dental schools in Saudi Arabia do not teach their students the use of sectional matrices in laboratory settings (Awad et al., 2017). Considering that using a sectional matrix is the gold standard when restoring a tooth with two missing walls (Bailey, 2021), dental schools in operative dentistry courses should modify their laboratory curriculum to impart more sessions in teaching sectional matrix placement and wedge insertion.

Remaining caries was observed 54 times, representing 8.04% of the reported single errors. Similar findings were observed in other studies where remaining caries was observed in 5.75% (AlOtaibi et al., 2020) and 12.60% (Bazerbashi et al., 2023) of the reported errors. This error was not found to be influenced by any factors, except when comparing citizen to non-citizen patients. This problem could be solved by mandating the use of magnification loupes in dental schools, which are an effective tool for diagnosing and observing remaining caries (Blumer et al., 2023). Close mentorship is critical to prevent dental restorations from being placed without final approval from the faculties, who must inspect the cavity preparation before approval. Dental students should also be well-educated to differentiate between infected and affected dental tissues.

5. Conclusion

Teaching class II resin composite restorations holds great significance in contemporary dentistry. This study reinforces the conclusions drawn from previous studies, which indicate a strong correlation between dental students and procedural errors in class II resin composite restorations. Dental schools may provide several approaches when teaching their students, such as implementing case-based learning, implementing regular assessments, and including practical exams (Bissell and Dawson, 2022; Park et al., 2016) to evaluate students' competency in performing class II resin composite restorations. In addition, it is crucial to enhance the comprehensiveness of laboratory training, exposing students to diverse clinical scenarios and various techniques.

Ethical Statement

This study was approved by the IAU Institutional Review Board (IRB-2023-02-298).

CRediT authorship contribution statement

Abdulrahman A. Balhaddad: Conceptualization, Methodology, Validation, Visualization, Supervision, Writing – review & editing. **Nawaf AlGhamdi:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing – original draft, Writing – review & editing. **Mohammed Alqahtani:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing – original draft, Writing – review & editing. **Osama A. Alsulaiman:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing – original draft, Writing – review & editing. **Ali Alshammari:** Conceptualization,

Table 5
Adjusted logistic regression models of the association between patient-, operator-, and clinical-related variables and the onset of class II resin composites' procedural errors (n = 777).

Outcome and Main Predictor	Odd Ratio	95% CI		P value
Internal Voids				
Tooth Type				
premolar	*Ref*			
Molar	0.39	0.25	0.60	**<0.0001**
Overhang				
Age				
18-40 years	*Ref*			
>40 years	1.79	1.04	3.11	**0.04**
Nationality				
Citizen	0.49	0.31	0.79	**0.003**
Non-citizen	*Ref*			
Tooth Number				
First	0.64	0.41	1.00	**0.04**
Second	*Ref*			
Internal Gap				
Student Level				
4th year	1.97	1.20	3.21	**0.008**
5th year	1.33	0.84	2.08	0.76
6th year	*Ref*			
External Gap				
Surface				
Mesial	0.38	0.19	0.78	**0.003**
Distal	0.66	0.34	1.27	0.774
MOD	*Ref*			
Marginal Depth				
Coronal to the CEJ	0.44	0.29	0.66	**<0.0001**
Apical to the CEJ	*Ref*			
Sharp Angle				
Tooth Type				
Premolar	*Ref*			
Molar	0.41	0.24	0.68	**<0.001**
Tooth Number				
First	1.86	1.16	2.99	**0.009**
Second	*Ref*			
Student Level				
4th year	1.95	0.95	3.97	0.75
5th year	3.17	1.72	5.82	**0.0003**
6th year	*Ref*			
Remaining Caries				
Nationality				
Citizen	0.49	0.27	0.93	**0.03**
Non-citizen	*Ref*			
Possible Open Contact				
Nationality				
Citizen	0.35	0.22	0.58	**<0.0001**
Non-citizen	*Ref*			
Tooth Type				
Premolar	*Ref*			
Molar	0.57	0.34	0.97	**0.04**

Cemento-enamel junction (CEJ); mesio-occluso-distal (MOD).

Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing – original draft, Writing – review & editing. **Malik J. Farraj:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing – original draft, Writing – review & editing. **Ahmed A. Alsulaiman:** Conceptualization, Methodology, Validation, Visualization, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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