10.5005/jp-journals-10019-1068
ORIGINAL RESEARCH

Comparison of Proximal Contact and Contours of Premolars restored with Composite Restoration using Circumferential Matrix Band with and without Separation Ring: A Randomized Clinical Trial

Farhan Raza Khan, Fahad Umer, Munawar Rahman

ABSTRACT

Aim: To compare the proximal contacts and contours in class II composite restorations in premolars achieved with Automatrix band with separation ring *vs* Automatrix band alone.

Materials and methods: A total of 188 premolar teeth with proximal cavity were assigned on alternate basis in two groups. Intervention group teeth received Automatrix band with separation ring using clamp forceps, while the control group received Automatrix band alone. All preparations were restored with P-60 composite (3M-ESPE Dental, USA). The outcome (proximal tightness) was determined by a blinded assessor. Chi-square test was applied to compare the contact tightness between the two groups. Spearman's rank correlation coefficient was applied to determine any correlation between the contact tightness with proximal contours. p-value of 0.05 was taken as significant.

Results: The intervention group exhibited better proximal contacts than the control group (p-value 0.040). There was no correlation between the contact tightness and the proximal contours.

Conclusion: The use of separation ring along with Automatrix matrix band in class II composite restorations resulted in significantly better proximal contacts than Automatrix band alone. However, the separation ring does not contribute in producing an additional improvement in the proximal contours. The proximal contour has no relationship with the proximal contact tightness.

Keywords: Proximal contact, Class II restorations, Composite restorations, Separation ring, Matrix band.

Clinical significance: Several techniques have been advocated to get tight contacts in composites including interdental separation ring. Our study focuses on using separation ring with circumferential matrix band instead of a sectional band. Moreover, we have attempted to study proximal tightness and proximal contours of composite restoration as separate variables.

How to cite this article: Khan FR, Umer F, Rahman M. Comparison of Proximal Contact and Contours of Premolars restored with Composite Restoration using Circumferential Matrix Band with and without Separation Ring: A Randomized Clinical Trial. Int J Prosthodont Restor Dent 2013;3(1):7-13.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Proximal contact plays an important role in protecting the periodontium against damage due to food impaction.[1-3] In amalgam restorations, a tight proximal contact in a class II preparation can be obtained by condensation of the material but for resin-based composites, the same is not true. It has always remained a challenge for the dentists to obtain tight proximal contact with composites.[4]

The clinical procedure of the proximal composite restoration has to compensate for the thickness of the matrix band as well as the polymerization shrinkage of the restorative material.[5] It was thought that employing thick consistency-packable composite could solve the problem but the 'packability' of the composite material has failed to achieve better contacts.[5,6]

Several operative techniques have been advocated to get good proximal contacts with composites. These include prewedging, multiple wedging, use of prepolymerized composite inserts, customized wedges, continuous force with instrument during light cure and composite ball method and so on. But none of these techniques guarantee success in all cases. [7-10]

The interdental separation technique appears to have a significant influence on the tightness of the resultant proximal contacts.[6] Various *in vitro* studies[4-6, 11-13] have shown that the use of separation ring may provide superior contact tightness in class II composite restoration. Later, this observation was confirmed in different randomized clinical trials.[14-16] The investigators of these trials consistently found that the contoured sectional matrix with separation ring almost always resulted in a stronger proximal contact. Unfortunately, these clinical trials have focused on the contacts but not on the proximal contours. While in clinical practice, achieving physiologic proximal contours is equally important. Therefore, we have speculated as to what difference an uncontoured circumferential matrix would bear on the proximal contact tightness.

It is known that the sectional matrices have limited applications. Because of their rounded contours, they do not always conform to the proximal contours and sometimes adjacent teeth are too close to allow their placement without causing a dent in the matrix material, rendering it unusable. Moreover, such precontoured matrix negates the concept of customizing the contact area as per the needs of an individual case.

Our study is aimed at devising a new intervention by combining the separation ring (BiTine separation ring by Palodent systems, Dentsply Caulk, Milford DE, USA) with the circumferential matrix band (Automatrix, Dentsply Caulk, Milford DE, USA) to get predictably tight contacts and anatomical contours achieved without using any precontoured bands.

OBJECTIVES

1. To compare the interproximal contacts in class II composite restorations in premolars achieved with the Automatrix band *vs* Automatrix-separation ring system.
2. To compare the Automatrix band with Automatrix-separation ring system in producing proximal contours in class II composite restorations in premolars.

MATERIALS AND METHODS

A clinical trial was conducted at the Operative Dentistry Clinics of the Aga Khan University Hospital Karachi, Pakistan from November 2007 to December 2011. A total of 188 teeth were selected among patients who had supragingival class II cavities in permanent premolars. Teeth with cavity isthmus less than one-third of intercuspal distance were inducted. Partially erupted teeth, teeth with noncarious tooth surface wear or with orthodontic bands or brackets or whose adjacent tooth continuous with the cavity side is missing were excluded.

The ethics review committee (Institutional Research Board) of the hospital approved the protocol before recruitment of the study subjects. The reference of the ethical clearance of this study from the hospital board is 640-Sur/ERC-06. The study is registered at www.clinicaltrials.gov with Identifier # NCT01662388.

Data Collection

Those patients who satisfied the inclusion criteria and gave written informed consent were enrolled in the study. After history and baseline clinical examination, a preoperative radiograph was taken using standardized X-ray cone positioning device, (Endoray II by Dentsply/ Rinn, USA, product code # 540303). Subjects were randomized by alternate group allocation. Half of the study subjects were assigned to the control group (Automatrix system alone), while the others were assigned the intervention group (Automatrix-separation ring system).

Procedure

Under local anesthesia, a class II cavity was prepared with high-speed handpiece using long pear shaped bur no. 245 or ADA # 330L (SS White, USA, product code # BU-52). The cavities were then refined with the hand instruments.

The control group teeth received Automatrix band alone (Wide-Regular type, dimensions 7.9 mm height and 0.05 mm thickness, product code # 62422513). It was secured on the prepared tooth and burnished against the adjacent tooth gently. Anatomical wedges were placed in the interproximal area gingival to the cavity preparation. Figure 1 shows Automatrix band and its wrench used among the controls.

Intervention group prepared teeth received Automatrix band (similar to the control group). The Automatrix was burnished against the adjacent tooth gently. Anatomical wedges were applied in the proximal area and then the separation ring (BiTine® round ring by Palodent systems, Dentsply International, DE, USA product # 659040) was placed with the help of retainer forceps. The separation rings are shown in Figure 2.

All prepared teeth were etched with 34% phosphoric acid (Tooth Conditioner Gel by Dentsply Caulk, Milford, DE, USA product code # 546150) then rinsed and dried. Then, a fifth generation adhesive [Adper™ Single Bond

Fig. 1: Automatrix band and tightening wrench

Fig. 2: Separation ring with wedges and ring placement forceps

Plus (3M-ESPE Dental, USA product catalog # 51102)] was applied, cured and subsequently restored with Filtek™ P60 posterior composite restorative (3M-ESPE Dental, USA product catalog # 4720B2) using incremental method. The restorative materials used in the study are shown in Figure 3. Restorations were carved and finished in the usual manner. After removal of the matrix band assembly, occlusion was adjusted and any high spots removed. The entire restoration was etched; bonding resin applied and polished using composite polishing material (Prisma Gloss, Dentsply Caulk, Milford, DE, USA, product code # 631400). Figures 4 to 6 show the preoperative, intraoperative and postoperative clinical steps of an intervention group tooth. A standardized postoperative radiograph was taken and compared with preoperative one. Figures 7 and 8 show the radiographic images.

Outcome Assessor

The coinvestigator who was blinded of the group allocation examined the study subjects for the outcome of interest. It was determined just after the completion of the restoration.

Fig. 3: Materials used in the dental restoration

Fig. 4: Preoperative clinical picture

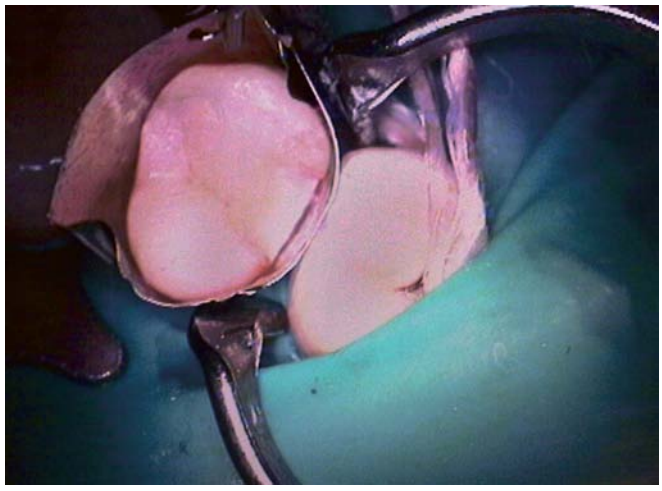


Fig. 5: Intraoperative clinical picture

Fig. 6: Postoperative clinical picture

Primary outcome was the tightness of the proximal contact area resulting in the two matrix band systems. It was measured using a 12 inch long nylon dental floss (Johnson and Johnson, USA).

Secondary outcome was the proximal contour and overhang of the restoration. These were examined clinically with an explorer and mouth mirror and then on the radiograph by the blinded coinvestigator.

Data Analysis

Data were analyzed using SPSS version 16.0 for windows. Descriptive statistics, such as mean and standard deviation of the quantitative variables were obtained. Independent sample t-test was carried out for difference between the means (continuous variables) of the two groups. Chi-square test was applied to assess the association between the categorical variables and the outcome. Spearman's rank order correlation coefficient was applied to determine any correlation between the outcome variables. A p-value of 0.05 and less was considered as statistically significant.

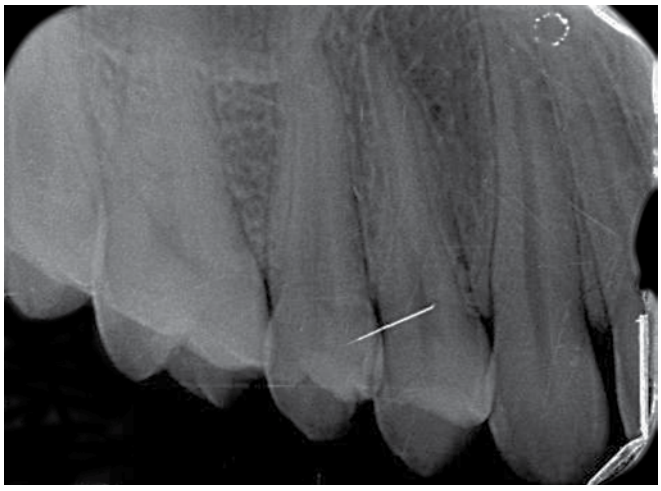
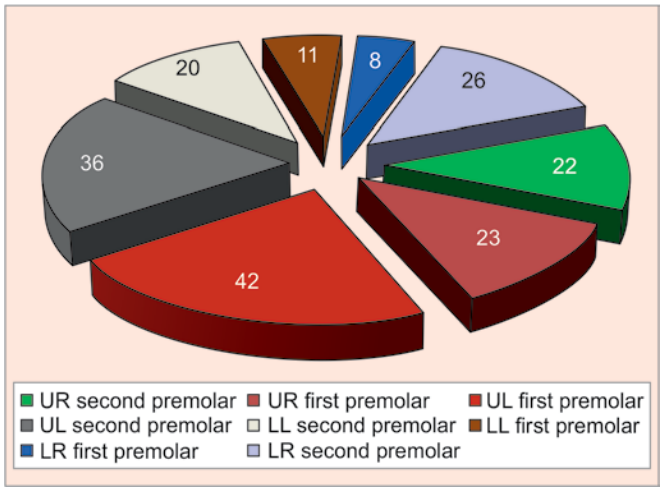


Fig. 7: Preoperative periapical radiograph



Pie Chart 1: Distribution of premolars in the study

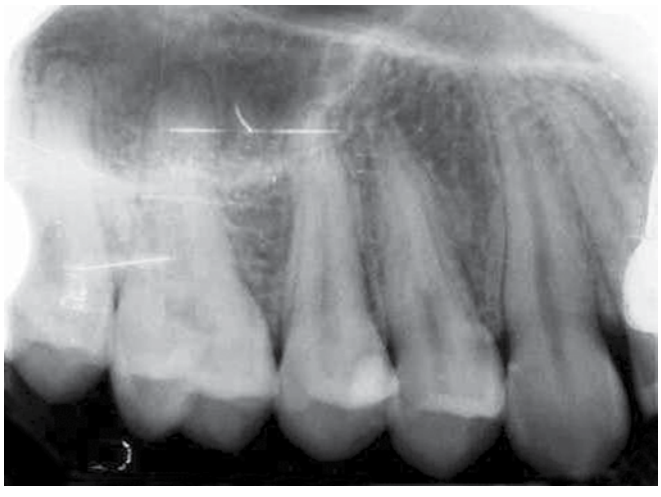


Fig. 8: Postoperative periapical radiograph

RESULTS

Premolars from all the quadrants were included in the study. The most frequent tooth treated in the study was upper left first premolar. The distribution of teeth is shown in Pie Chart 1. There were no statistically significant differences (in terms of age of the subjects and the prepared cavity dimensions) found between the two groups. Thus, the two study groups were comparable at the baseline (Table 1).

Table 1: Baseline characteristics (n = 188)

Variable	*Group*	*Mean (SD)*	*p-value*
Age in years	1	34.79 (10.5)	0.608
	2	33.95 (11.8)	
Perpendicular distance between prepared gingival floor and adjacent tooth	1	2.48 (0.3)	0.241
	2	2.42 (0.3)	

Baseline comparison between the two study groups. Group 1 is the automatrix alone (control), while group 2 comprised of automatrix with separation ring (intervention). Independent sample t-test was applied at 0.05 level of significance; SD: Standard deviation

Table 2 shows that a greater proportion of restored teeth in the Automatrix-separation ring group (82/94) exhibited tighter proximal contact than the control group (70/94). Thus, application of separation ring to Automatrix assembly resulted in significantly better proximal contact (p-value 0.040).

The secondary outcomes, such as proximal contours and overhangs were marginally better in the Automatrix-separation ring group, but the difference was not statistically significant (Table 3).

Table 4 shows that there is a highly significant correlation between clinical and radiographic assessment of proximal contours. It means that if a clinician is able to detect inadequate proximal contour on a radiograph, the chances of the same being detected clinically are around 96%. Similarly, correlation between clinical and radiographic assessment of overhangs is around 86.4%. However, there was no correlation found between the proximal contact tightness and the contours of the composite restoration. This signifies that proximal contacts and contours are two independent entities.

DISCUSSION

In clinical studies, the tightness of the proximal contact is measured by passing a dental floss through the contact area and scoring the contact strength as 'satisfactory', 'acceptable' or 'unacceptable'.[8,17] Unfortunately, this method is not sensitive enough to record minor changes in the contact strength. There are devices that can objectively measure the contact strength. The first instrument was designed by Loomans et al[11] at University of Technology at Delft, Netherland. While the second-one was reported by investigators at University of Tokushima, Korea.[18] These instrument measure proximal contact strength (PCS) in unit of force, that is, Newton. But as these devices are not commercially available, therefore; we were compelled to assess the outcome in our using traditional method of floss.

Table 2: Primary outcome: tightness of the interproximal contact

Variable (n = 188)	*Categories*	*Group 1 (automatrix alone)*	*Group 2 (automatrix with separation ring)*	*Chi-square value*	*df*	*p-value*
Tightness of contact assessed with floss	Good contact	70	82	4.947	1	0.040 *
	Acceptable or less	24	12			

Comparison of the proximal contact tightness of the two study groups; Chi-square test is applied; the level of significance was set at 5%; *Statistically significant difference; df: Degree of freedom

Table 3: Secondary outcomes: proximal contours and overhangs

Variable (n = 188)	*Categories*	*Group 1 (automatrix alone)*	*Group 2 (automatrix with separation ring)*	*p-value*
Proximal contours clinical assessment	Good	86	89	
	Acceptable	8	5	0.388
Proximal contours radiographic assessment	Good	86	88	
	Acceptable	8	6	0.578
Ledge or overhang assessed with floss	No ledge	87	88	
	Ledge present	7	6	0.744
Ledge or overhang assessed with X-ray	No overhang	85	86	
	Overhang	9	8	0.799

Comparison of the two study groups with respect to proximal contours and overhang formation; Chi-square test was applied and the level of significance was set at 0.05

Table 4: Correlation among proximal contact, proximal contours and overhangs

Spearman's rho		*Contours clinical assessment*	*Contours radiographic assessment*	*Ledge assessed with floss*	*Ledge assessed with X-ray*	*Tightness assessed with floss*
Proximal contours clinical assessment	rho	1				
	p-value	—				
Proximal contours radiograph assessment	rho	0.961 *	1			
	p-value	<0.001	—			
Ledge or overhang assessed with floss	rho	–0.074	–0.077	1		
	p-value	0.311	0.292	—		
Ledge or overhang assessed with X-ray	rho	–0.086	–0.089	0.864 *	1	
	p-value	0.241	0.222	<0.001	—	
Tightness of contact assessed with floss	rho	0.076	0.064	0.087	0.040	1
	p-value	0.297	0.385	0.235	0.589	—

The Spearman's rank-order correlation coefficient is applied to measure the strength of linear association between ranked variables; *Statistically significant correlation

There is a strong evidence base in favor of employing separation ring for class II composite restorations. The studies[4-6,11-13,14-16] in this regards actually recommend using separation ring in combination with sectional matrices. But it is not clear whether the positive results (tight contact) achieved by sectional matrix–separation ring assembly is attributed to the matrix or to the separation ring. Our study is distinct, as we have attempted to address this by using the separation ring without a precontoured sectional matrix. Thus, we have eliminated the effect of the contoured surface of the sectional matrix. With results (Table 2), we inferred that it is the separation ring that is mainly responsible for the tighter contacts.

Use of a separation ring along with circumferential matrix was first proposed by Bracket et al.[19] As it was a case report; hence, the evidence in its favor was weak. Our study has attempted to employ an unusual combination and to the best of our knowledge, no trial has ever combined these together before, thus, our technique is innovative.

In the present study, premolars from all quadrants were included (Pie Chart 1); hence, the results can be extrapolated to both maxillary and mandibular premolars. Table 1 shows that at baseline both the groups were comparable with respect to the age of the participants, dimension of the prepared cavities and their distance with the adjacent teeth.

The separation ring group exhibited significantly better PCS (Table 2). Same composite resin was used for all restorations and similarly the placement was identical, that is, small increment of less than 2 mm in both the groups so it was also not variable in the study. The only difference

was employment of the separation ring. Thus, the improved contact tightness can be attributed to the separation ring. To explain the restorations with a loose or less than optimal proximal contact (12 out of 94) in the intervention group, it is likely that either the separation ring was not effective in separating the teeth or the clinician was no able to position it effectively. Similarly, the explanation of less than optimal proximal contact in control group could be attributed to relatively less movement of adjoining teeth resulting from wedge placement. Similar findings were reported by Kampouropoulos et al,[8] who concluded that no technique is ideal to sufficiently reconstruct the proximal contact characteristics of an intact tooth.

Studies on the proximal contacts tightness address the contour and contact as a single entity.[14-16] In clinical practice, it is not uncommon to observe good proximal contact but inadequate contours in proximal restorations. Similarly, a scenario where a good contour with poor proximal contact exists can also be a possibility. This can be observed in teeth adjacent to porcelain fused to metal crown.[20] The present study is distinct, as we have addressed the proximal contacts and contours as two separate variables. The results emphasized that the proximal contact tightness is not related with the contours. In fact, the contact tightness is dependent largely on the technique utilized for proximal restoration, while contour is a function of manipulation of the inner surface of matrix band. No relevant research study so far was found on the lack of association between contact and contours.

There was no significant difference in overhang formation in the two groups (Table 3). Nearly 10% of teeth developed overhangs in each group. Probably, it has more to do with the technique of matrix band and wedge placement than any other variable. Chuang et al[13] attributed the interproximal marginal overhang to surface concavity resulted from band placement and ring application.

With increasing number of dentist using composites in selected posterior load bearing situations, a proportion of practitioners still do not prefer to place composite at all in the class II preparations. The use of separation ring has no room in proximal amalgam restorations, as it is neither indicated nor has any clinical advantage there. Inadvertent use of separation ring for amalgam restoration may result in an aggressive tooth movement and place the freshly restored tooth at a greater risk of amalgam fracture during the removal of separation ring and matrix band assembly. Therefore, use of such separation rings should be reserved for composites restorations only.

Another issue with class II composites is the phenomenon of proximal wear. The contact strength of proximal restoration does not remain stable. In fact, it is supposed to change overtime on account of mesial movement and proximal wear.[15] It is not known whether the proximal wear occurs differentially on contacts built with different operative techniques. However, Demarco et al[21,22] showed that proximal contacts built with composites showed poor performance on 2 and 4 years follow-up. Therefore, long-term follow-up of proximal composite restorations is warranted.

One of the limitations of our study was that we had just two study groups. Ideally, a third group, that is, sectional matrix with a separation ring should have been planned in the protocol. Presence of this third group would have resulted in an interesting comparison of proximal contacts and contours. Moreover, we assessed proximal contacts with periapical radiographs. It is known that bite wing radiographs are superior to periapical radiographs for this purpose. Therefore, we should have used bite wing radiographs to assess the outcome. But we justified using periapical radiographs for the reason of calibrating it with preoperative image and to strictly adhere with the written protocol.

The technique of using separation ring with Automatrix is easy to do clinically and does not require any special products or learning additional skills. As more dentists are now using direct composites for class II preparations; this technique can be a cost-effective way to deliver a high-quality predictable restoration.

CONCLUSION

The use of separation ring-Automatrix band assembly in class II composite restorations in premolars resulted in tighter proximal contacts than Automatrix alone.

The use of separation ring does not contribute to any additional improvement in proximal contours than what can be achieved with Automatrix alone.

The proximal contour and overhangs have no relationship with the proximal contact tightness.

ACKNOWLEDGMENTS

The study was financially supported by Dental Section, Aga Khan University Hospital, Pakistan. The study protocol was approved by the Aga Khan University's ethics review committee. The reference of our protocol is ERC Ref: 640-Sur/ ERC-06.

REFERENCES

1. Ash MM. Wheeler's dental anatomy, physiology and occlusion. 8th ed. St. Louis, MO: Elsiever 2003; p 121-129.
2. Hancock EB, Mayo CV, Schwab RR, Wirthlin MR. Influence of interdental contacts on periodontal status. J Periodontol 1980 Aug;51(8):445-449.
3. Jernberg GR, Bakdash MB, Keenan KM. Relationship between proximal tooth open contacts and periodontal disease. J Periodontol 1983 Sep;54(9):529-533.

4. Saber MH, Loomans BA, El Zohairy A, Dörfer CE, El-Badrawy W. Evaluation of proximal contact tightness of class II resin composite restorations. Oper Dent 2010 Jan-Feb;35(1):37-43.
5. Loomans BA, Opdam NJ, Roeters JF, Bronkhorst EM, Plasschaert AJ. Influence of composite resin consistency and placement technique on proximal contact tightness of class II restorations. J Adhes Dent 2006 Oct;8(5):305-310.
6. Peumans M, Van Meerbeek B, Asscherickx K, Simon S, Abe Y, Lambrechts P, Vanherle G. Do condensable composites help to achieve better proximal contacts? Dent Mater 2001 Nov;17(6):533-541.
7. Roberson TM, Heymann HO, Swift EJ. Sturdevant's art and science of operative dentistry. 4th ed. St. Louis, MO: Mosby; 2006 p 32-35.
8. Kampouropoulos D, Paximada C, Loukidis M, Kakaboura A. The influence of matrix type on the proximal contact in Class II resin composite restorations. Oper Dent 2010 Jul-Aug;35(4):454-462.
9. Summitt JB, Robbins JW, Schwartz RS. Fundamentals of operative dentistry: a contemporary approach. Carol Stream, IL: Quintessence 2000; p 34-35.
10. Klein F, Keller AK, Staehle HJ, Dörfer CE. Proximal contact formation with different restorative materials and techniques. Am J Dent 2002 Aug;15(4):232-235.
11. Loomans BA, Opdam NJ, Roeters FJ, Bronkhorst EM, Burgersdijk RC. Comparison of proximal contacts of Class II resin composite restorations in vitro. Oper Dent 2006 Nov-Dec;31(6):688-693.
12. Loomans BA, Roeters FJ, Opdam NJ, Kuijs RH. The effect of proximal contour on marginal ridge fracture of Class II composite resin restorations. J Dent 2008 Oct;36(10):828-832.
13. Chuang SF, Su KC, Wang CH, Chang CH. Morphological analysis of proximal contacts in class II direct restorations with 3D image reconstruction. J Dent 2011 Jun;39(6):448-456.
14. Loomans BA, Opdam NJ, Roeters FJ, Bronkhorst EM, Burgersdijk RC, Dörfer CE. A randomized clinical trial on proximal contacts of posterior composites. J Dent 2006 Apr;34(4):292-297.
15. Loomans BA, Opdam NJ, Roeters FJ, Bronkhorst EM, Plasschaert AJ. The long-term effect of a composite resin restoration on proximal contact tightness. J Dent 2007 Feb;35(2):104-108.
16. Wirsching E, Loomans BA, Klaiber B, Dörfer CE. Influence of matrix systems on proximal contact tightness of 2- and 3-surface posterior composite restorations in vivo. J Dent 2011 May;39(5):386-390.
17. Cenci MS, Lund RG, Pereira CL, de Carvalho RM, Demarco FF. In vivo and in vitro evaluation of class II composite resin restorations with different matrix systems. J Adhes Dent 2006 Apr;8(2):127-132.
18. Oh SH, Nakano M, Bando E, Shigemoto S, Kori M. Evaluation of proximal tooth contact tightness at rest and during clenching. J Oral Rehabil 2004 Jun;31(6):538-545.
19. Brackett MG, Contreras S, Contreras R, Brackett WW. Restoration of proximal contact in direct class II resin composites. Oper Dent 2006 Jan-Feb;31(1):155-156.
20. Durr-E-Sadaf, Ahmad Z. Porcelain fused to metal (PFM) crowns and caries in adjacent teeth. J Coll Physicians Surg Pak 2011 Mar;21(3):134-137.
21. Demarco FF, Cenci MS, Lima FG, Donassollo TA, André Dde A, Leida FL. Class II composite restorations with metallic and translucent matrices: 2-year follow-up findings. J Dent 2007 Mar;35(3):231-237.
22. Demarco FF, Pereira-Cenci T, de Almeida André D, de Sousa Barbosa RP, Piva E, Cenci MS. Effects of metallic or translucent matrices for Class II composite restorations: 4-year clinical follow-up findings. Clin Oral Investig 2011 Feb;15(1):39-47.

ABOUT THE AUTHORS

Farhan Raza Khan (Corresponding Author)

Assistant Professor, Department of Surgery, Dental Section, Aga Khan University, Sindh, Pakistan, Phone: 00922134863940 e-mail: farhan.raza@aku.edu

Fahad Umer

Senior Instructor, Department of Surgery, Dental Section, Aga Khan University, Sindh, Pakistan

Munawar Rahman

Senior Lecturer, Department of Surgery, Dental Section, Aga Khan University, Sindh, Pakistan