Comparison of Two Different Matrix Band Systems in Restoring Two Surface Cavities in Posterior Teeth Done by Senior Undergraduate Students at Qassim University, Saudi Arabia: A Randomized Controlled Clinical Trial

Abstract

Context: Dental students commonly face the problem of overhanging proximal margins and unsatisfactory proximal contact points (PCPs) while restoring Class II cavities in posterior teeth. Various matrix band systems are used in dental clinics to avoid such problems. Aims: The aim of this study is to compare the effects of two matrix band systems, circumferential matrix system and sectional matrix system on the PCPs and contours when restoring Class II cavities in posterior teeth. Settings and Design: This was a randomized controlled clinical trial done at College of Dentistry, Qassim University, Saudi Arabia. Subjects and Methods: Total 1200 Class II cavities in teeth were selected for this study. Treatment was done by senior undergraduate students. Cavities were randomly divided into two groups. Group 1: Total 600 cavities were restored using circumferential band system. Group 2: Total 600 cavities were restored using sectional band system. Teeth were restored either with the composite or the amalgam restoration. Contact points were evaluated. The presence or absence of proximal overhangs was assessed. Overhanging margins were categorized as positive overhangs, negative overhangs, and absent overhangs. Statistical Analysis Used: To identify the relationship between matrix band systems and other factors, Chi-square tests (χ²-tests) and Z-tests were used. Pearson correlation coefficient was computed and logistic regression analysis was carried out to assess variables that can affect proximal margins and contact points of final restorations. Results: All optimum contacts 389 (100%) were found in restorations done using sectional band system. A highly significant association was found between open contact points and negative overhanging margins with the use of circumferential matrix band system (P < 0.00). Conclusion: Sectional matrix band system has been found superior to circumferential matrix band system.

Keywords: Matrix band system, proximal contact, resin composite

Introduction

Creation of anatomically optimum contact points with direct restorations still remains difficult.[1,2] Posterior restorations can frequently exhibit various problems, for example, improper contact points, proximal overhangs, etc.[3] Improper condensation of the restorative material and polymerization shrinkage of restorative material may be responsible for these problems.[4-6] Many research studies have shown comparison of amalgam and composite restorations and demonstrated different results.[7-14]

A contact which is not adequate usually results in food impaction, periodontal disease, and movement of tooth.[15-17] Matrix band system is used to restore cavities with missing proximal walls.[3] Circumferential matrix band system has been conventionally used to restore the Class II cavities.[17] Sectional matrix band system is relatively new and has shown to produce anatomically optimum contact points.[18-22]

The objective of this study was to evaluate the effects of two matrix band systems on the proximal contacts and contours while restoring two surface cavities by senior undergraduate students in posterior teeth.

Subjects and Methods

Ethical approval was obtained from University Ethical Approval Committee and Dental Research Center (Code EA#612014). Total 1074 patients in need of two surface
Class II direct restorations participated in this study from December 20, 2014, to June 2, 2016. Inclusion criteria were patients with good general health, minimum age of 18, and fully erupted occluding premolar and molar teeth. Exclusion criteria were severe periodontal diseases, diastema between posterior teeth, third molar teeth, presence of fixed partial dentures, and tooth mobility more than score 1.

Total 1345 Class II cavities were initially assessed for eligibility for this study. Total 77 cavities were excluded from enrollment; 68 cavities were excluded from randomization due to gingival bleeding near the proximal gingival margin of the cavity because this was affecting isolation [Figure 1].

Total 52 male and 25 female students participated in this study.

Total 1200 Class II cavities were randomly assigned to senior undergraduate students (4th-year and 5th-year students). Teeth were divided into two groups. Total 1200 Class II cavities were randomly assigned to senior undergraduate students. Simple randomization technique involving random number table was used. About 1200 random numbers were selected from random number table, 600 of which assigned to (Group 1) circumferential matrix band system, and 600 were assigned to sectional matrix band system (Group 2). Teeth were divided into two groups.

Group 1

Six hundred teeth were restored using a precontoured circumferential matrix band system (Hawe Contoured Tofflemire Bands 1101-C, KerrHawe, thickness: 0.035 mm) placed around the tooth in a retainer (Tofflemire Retainer Universal 1140, KerrHawe). Separation was achieved by placing a wooden wedge (Hawe Neos, set No. 823, sorted) interdentally at the side of the preparation. The size of the wedge was determined by the individual interdental space with the tip just fitting into it, and the wedge was then pushed until the triangular part was completely inserted. When the matrix band had no direct contact to the adjacent tooth, the contact area of the matrix band was burnished with an adequate instrument (ball burnisher C 9, Hu Friedy, Chicago, USA) toward the adjacent tooth.

Group 2

Six hundred teeth were restored using a precontoured sectional matrix system (Palodent matrix bands, standard, thickness: 0.038 mm). The sectional matrix band was placed interproximally and secured with a wooden wedge for achieving optimal adaptation of the matrix band in the cervical region. Then, the separation ring (BiTine® Ring, DENTSPLY International Inc., Milford, DE, USA) was placed.

Cavity restoration

After placing the matrix system, preparations were etched for 15 s. The cavities were restored using a three-step adhesive system (Optibond FL, Kerr Corporation, West Collins, USA) and a hybrid-filled composite. The composite resin was applied in a multilayering technique, and each layer was cured for 20 s from the occlusal surface using a polymerization unit (Elipar 2, 3M ESPE, Seefeld, Germany). After removal of the matrix, restorations were postcured for 20 s from both buccal and lingual sides. Restorations were finished using fine-grit diamond burs (FG 257F023, FG166C010, Horico) and Sof-Lex™ discs, and the occlusion was checked with articulating paper (Bausch Articulating paper, 40 μm).

In amalgam restoration cases after placement of matrix band system, cavities were restored using Tytin amalgam (Kerr Corporation, Orange, CA, USA).

Selection of restorative materials was done according to the merit mentioned by Forsee and Widstrom.[23]

Proximal contact point (PCP) tightness was measured by passing a dental floss (Oral-B® Essential Floss tarpaulin) using the method described by Kim et al., Durr-e-Sadaf and Ahmad, and Akhtar et al.[24-26] The dental floss was
wrapped around the index fingers of both hands, and floss was passed through the PCPs which were to be assessed. PCP was categorized as optimum, open, and tight. If dental floss could be passed with little resistance or as much resistance as in natural dentition on the other side, it was considered as optimum contact point. Open PCPs were those which allowed the dental floss to pass without resistance. If dental floss could not be passed at all or shredded, it was categorized as tight.

All measurements were performed by one investigator (MZA) who is a senior subject specialist and was blinded from the type of matrix band used, while the patient sitting in a dental unit with a standardized seating position, which was reproduced by the unit’s preset positioning system.

The presence or absence of proximal overhangs of restorations was assessed with a standardized set up using indirect digital PSP system of bitewing radiographs (Digora Optime, Soredex) with a film holding system (XCP, RINN Corporation, Elgin, IL, USA). Overhangs were categorized as positive overhangs, negative overhangs, and absent overhangs. If an excess of filling material was found beyond the cavity margin or normal tooth structure at the proximal step of the restoration, it was categorized as positive overhang. If filling material was found short of the cavity margin or normal tooth structure at the proximal step of the restoration, it was categorized as negative overhang. If there was a smooth transition of filling material and tooth surface at the proximal step of restoration, it was categorized as absent overhang.

Location of the cavity margins was assessed clinically and by digital bitewing radiograph. Location of the cavity margins was categorized as above cementoenamel junction (CEJ), below CEJ, and at CEJ. Location of the cavity was categorized as mesio-occlusal cavity and disto-occlusal cavity.

Statistical analysis was performed using statistical software package SPSS 20.(SPSS Inc., Chicago, IL 60606, USA). To identify the relationship between matrix band system and other factors, we performed Chi-square tests ($\chi^2$-tests) and Z-tests. Logistic regression analysis was carried out to assess variables that can affect proximal margins and contact points of final restorations. Pearson correlation test was done to rule out the possibility of any correlation between overhanging margins and presence of optimum and tight contact points. $P < 0.05$ was considered as significant at 95% confidence interval.

### Results

Matrix band systems were randomly divided into sectional (600) and circumferential matrix band group (600) teeth. Proximal contacts were evaluated. Open contacts were found in 739 (61.6%) teeth. Tight contacts were found in 72 (6%) teeth. Optimum contacts were found in 389 (32.4%) teeth. All 389 (100%) optimum contact points were present in teeth restored using sectional matrix band system. Chi-square test was done to find the association of type of matrix band system used and PCPs. A highly significant association was found between open contact points and use of circumferential matrix band system ($P < 0.00$) [Table 1].

On postoperative bitewing radiograph, positive overhanging margins were found in 142 teeth. Negative overhanging margins were found in 132 (11%) teeth. Absent overhanging margins were found in 926 (77.2%) teeth. Overhanging margins and their association with matrix band system were assessed using Chi-square test and Z-test. Absent overhangs were significantly associated with sectional matrix band system ($P = 0.005$) when Z-test was applied. Similarly, circumferential matrix band system was found to be significantly associated with negative overhanging margins ($P < 0.00$) [Table 2].

Total 320 (26.7%) cavities margins were located below CEJ, 237 (19.7%) cavities margins were located at CEJ,
and 643 (53.6%) cavities margins were located above CEJ. Student’s preference for matrix band system was noted. In 200 (16.7%) cases, students preferred using sectional matrix band system and 1000 (83.3%) cases students preferred using circumferential matrix band system.

A logistic regression analysis was done. The estimated odds ratio (OR) of tooth treated (OR = 1.016, 95% confidence interval [CI]: 1.001–1.032), proximal margins of restoration on postoperative bitewing radiograph (OR = 1.564, 95% CI: 1.135–2.156), PCPs (OR = 33.589, 95% CI: 20.568–54.854), student’s preference (OR = 2.115, 95% CI: 1.354–3.304), and year of student (OR = 4.075 95% CI: 2.519–6.594) found to have significant association with matrix band system (P < 0.05) [Table 3]. This means that there are greater chances of overhanging proximal margins and faulty contact points if the restorations were placed using circumferential matrix band system as compared to sectional matrix band system [Tables 1 and 2]. To rule out the possibility that overhanging restorations may have a correlation with tight and optimum contact points, a Pearson correlation coefficient was computed. There was nonsignificant correlation between presence of overhanging margins and tight and optimum contact points (r = 0.171, n = 98, P > 0.092) [Table 4].

**Discussion**

The objective of this randomized clinical trial was to assess contact point optimization and proximal contour in Class II cavities using conventional circumferential and sectional band system. Sectional band with separation ring (Palodent) performed better than circumferential band in terms of achieving optimum contact points. The reasons are most probably the use of separation ring and sectional matrix. There are a number of studies that showed that sectional matrix band with separation ring is the most reliable device for restoring contact points in posterior teeth. [20,27,28]

A study done by Loomans et al. in 2005 comparing circumferential band and sectional band found that the sectional band with separation ring is associated with greater strength of the contact points. [20]

A strong association between restoration overhang and different matrix band systems also has been found, and no restoration overhang was found in cavities restored with sectional band system. An optimum proximal contour can also be achieved with sectional matrix band with separation ring. [20,27,28]

After the introduction of direct composite as restorative materials more than 60 years ago, the use of amalgam restorations is constantly declining. [25,26] At present, with change in world policies, for example, some founded at Minamata convention which necessitates the reduction in use mercury-contained dental amalgam restorations, composite resin has become the most commonly used type of restorative material. [28] Furthermore, it is reported that posterior restorations can exhibit discrepancies, for example, improper margins and faulty contact points, etc. [14] With these facts in mind, our study aimed to evaluate trends in materials usage, material selection, and quality of restorations in posterior teeth done by senior undergraduate students in free of charge dental clinics at government dental college in Saudi Arabia.

A maximum number of cavities in our study were restored with composites (88.4%). This is consistent with the literature that younger operators choose composite restorative material more frequently when compared to older dentists. [27,29,30]

Open contact points were significantly associated with circumferential matrix band system (P < 0.005). Our results are consistent with the other studies where more optimum proximal contacts were found when Class II cavities were restored using sectional matrix band and separation ring when compared to traditional

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**Table 3: The estimated logistic coefficients of factors from logistic regression model to matrix band system dichotomous data**

| Variables in equation            | B      | SE    | Wald df | Significant | Exp(B) | 95% CI for Exp(B) |
|----------------------------------|--------|-------|---------|-------------|--------|------------------|
| Gender                          | 0.567  | 0.716 | 0.627   | 1           | 0.429  | 1.763            | 0.433 | 7.177            |
| Tooth treated                   | 0.16   | 0.008 | 4.186   | 1           | 0.041  | 1.016            | 1.001 | 1.032            |
| Cavity location                 | 0.225  | 0.183 | 1.520   | 1           | 0.218  | 1.253            | 0.876 | 1.792            |
| Student’s gender                | 0.049  | 0.722 | 0.005   | 1           | 0.946  | 1.050            | 0.255 | 4.328            |
| Margins of cavity              | 0.182  | 0.116 | 2.460   | 1           | 0.117  | 1.200            | 0.955 | 1.507            |
| Type of restoration             | 0.468  | 0.296 | 2.509   | 1           | 0.113  | 1.597            | 0.895 | 2.850            |
| Restoration margins on postoperative radiograph | 0.448  | 0.164 | 7.482   | 1           | 0.006  | 1.564            | 1.135 | 2.156            |
| Proximal contact points         | 3.514  | 0.250 | 197.202 | 1           | 0.000  | 33.589           | 20.568 | 54.854           |
| Preference of students          | 0.749  | 0.228 | 10.821  | 1           | 0.001  | 2.115            | 1.354 | 3.304            |
| Student’s year                  | 1.405  | 0.246 | 32.744  | 1           | 0.000  | 4.075            | 2.519 | 6.594            |
| Constant                        | −12.452| 1.190 | 109.452 | 1           | 0.000  |                   |       |                 |

CI = Confidence interval, SE = Standard error
The role of matrix band system in Class II cavity restorations

Table 4: Correlation between presence of overhanging margins and contact points (tight and optimum proximal contact points)

| Proximal margins | Proximal contacts | Total (%) | r    | P     |
|------------------|-------------------|-----------|------|-------|
| Positive         | Tight (%)         | 22 (22.4) | 67 (68.4) | 89 (90.8) | 0.171 | 0.092 |
|                  | Optimum (%)       |           |       |       |       |       |
| Negative         |                   | 0         | 9 (9.2) | 9 (9.2) |       |       |
| Total            |                   | 22 (22.4) | 76 (77.6) | 98 (100) |       |       |

Pearson correlation test was used at 95% CI, α=5%. CI=Confidence interval.

Proximal contact and absent overhanging margins as compared to the use of the circumferential matrix system.

Recommendation

The use of various matrix band systems including sectional matrix band system should be emphasized during the simulation laboratory preclinical operative dentistry course.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Santos MJ. A restorative approach for class II resin composite restorations: A two-year follow-up. Oper Dent 2015;40:19-24.
2. 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;39:386-90.
3. Quadir F, Ali Abidi SY, Ahmed S. Overhanging amalgam restorations by undergraduate students. J Coll Physicians Surg Pak 2014;24:485-8.
4. Burke FJ, Shortall AC. Successful restoration of load-bearing cavities in posterior teeth with direct-replacement resin-based composite. Dent Update 2001;28:388-94, 396, 398.
5. Dörfer CE, Schriever A, Heidenmann D, Staehle HJ, Pioch T. Influence of rubber-dam on the reconstruction of proximal contacts with adhesive tooth-colored restorations. J Adhes Dent 2001;3:169-75.
6. Rau PJ, Pioch T, Staehle HJ, Dörfer CE. Influence of the rubber dam on proximal contact strengths. Oper Dent 2006;31:171-5.
7. Opdam NJ, Bronkhorst EM, Roeters JM, Loomans BA. A retrospective clinical study on longevity of posterior composite and amalgam restorations. Dent Mater 2007;23:8-23.
8. Sunnegårdh-Grönberg K, van Dijken JW, Funegård U, Lindberg A, Nilsson M. Selection of dental materials and longevity of replaced restorations in public dental health clinics in Northern Sweden. J Dent 2009;37:673-8.
9. Raskin A, Michotte-Theall B, Vreven J, Wilson NH. Clinical evaluation of a posterior composite 10-year report. J Dent 1999;27:13-9.
10. Baratieri LN, Ritter AV. Four-year clinical evaluation of posterior resin-based composite restorations placed using the total-etch technique. J Esthet Restor Dent 2001;13:50-7.
11. Smales RJ. Longevity of low- and high-copper amalgams analyzed by preparation class, tooth site, patient age, and operator. Oper Dent 1991;16:162-8.
12. de Souza FB, Guimarães RP, Silva CH. A clinical evaluation of packable and microhybrid resin composite restorations: One-year report. Quintessence Int 2005;36:41-8.
13. Loguercio AD, Reis A, Rodrigues Filho LE, Busato AL. One-year clinical evaluation of posterior packable resin composite restorations. Oper Dent 2001;26:427-34.
14. Türkün LS, Akteren BO. Twenty-four-month clinical evaluation of different posterior composite resin materials. J Am Dent Assoc 2001;132:196-203.
15. Abrams H, Kopczyk RA. Gingival sequelae from a retained piece of dental floss. J Am Dent Assoc 1983;106:57-8.
16. Lynch CD, Opdam NJ, Hickel R, Brunton PA, Gurgan S, Kakaboura A, et al. Guidance on posterior resin composites.
Academy of Operative Dentistry – European Section. J Dent 2014;42:377-83.

17. van der Vyver PJ. Posterior composite resin restorations. Part 3. Matrix systems. SADJ 2002;57:221-6.

18. Peumans M, Van Meerbeck B, Asscherickx K, Simon S, Abe Y, Lambrechts P, et al. Do condensable composites help to achieve better proximal contacts? Dent Mater 2001;17:533-41.

19. Loomans BA, Opdam NJ, Roeters FJ, Bronkhorst EM, Plasschaert AJ. Influence of composite resin consistency and placement technique on proximal contact tightness of Class II restorations. J Adhes Dent 2006;8:305-10.

20. Loomans BA, Opdam NJ, Roeters FJ, Bronkhorst EM, Burgersdijk RC, Dörfer CE, et al. A randomized clinical trial on proximal contacts of posterior composites. J Dent 2006;34:292-7.

21. Kim HS, Na HJ, Kim HJ, Kang DW, Oh SH. Evaluation of proximal contact strength by postural changes. J Adv Prosthodont 2009;1:118-23.

22. Akhtar Q, Danyal S, Zareen S, Ahmed B, Maqsood M, Azad AA, et al. Clinical evaluation of proximal contact points in fixed prostheses. J Coll Physicians Surg Pak 2015;25:702-4.

23. Fors H, Widström E. From amalgam to composite: Selection of restorative materials and restoration longevity in Finland. Acta Odontol Scand 2001;59:57-62.

24. Durr-E-Sadaf, Ahmad Z. Porcelain fused to metal (PFM) crowns and caries in adjacent teeth. J Coll Physicians Surg Pak 2011;21:134-7.

25. Ben-Gai G, Weiss EI. Trends in material choice for posterior restorations in an Israeli dental school: Composite resin versus amalgam. J Dent Educ 2011;75:1590-5.

26. Lynch CD, Wilson NH. Managing the phase-down of amalgam: Part I. Educational and training issues. Br Dent J 2013;215:109-13.

27. 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;31:688-93.

28. Müllejans R, Badawi MO, Raab WH, Lang H. An in vitro comparison of metal and transparent matrices used for bonded class II resin composite restorations. Oper Dent 2003;28:122-6.

29. Khalaf ME, Alomari QD, Omar R. Factors relating to usage patterns of amalgam and resin composite for posterior restorations – A prospective analysis. J Dent 2014;42:785-92.

30. O’Sullivan CO, McKenna GJ, Burke FM. Trends in material choice for direct restorations by final year students from University College Cork 2004-2009. Eur J Prosthodont Restor Dent 2012;20:31-4.

31. Arhun N, Cehreli SB. Do adhesive systems leave resin coats on the surfaces of the metal matrix bands? An adhesive remnant characterization. Int J Periodontics Restorative Dent 2013;33:e43-50.

32. Opdam NJ, Bronkhorst EM, Loomans BA, Huysmans MC. 12-year survival of composite vs. Amalgam restorations. J Dent Res 2010;89:1063-7.

33. Moura FR, Romano AR, Lund RG, Piva E, Rodrigues Júnior SA, Demarco FF, et al. Three-year clinical performance of composite restorations placed by undergraduate dental students. Braz Dent J 2011;22:111-6.