Review Article

Proximal contact tightness of direct Class II composite resin restorations with various matrix systems: A systematic review

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Abstract

Background: Restoring an ideal proximal contact in direct Class II composite resin restorations is challenging due to polymerization shrinkage, absence of condensability of composite materials, thickness of matrix bands, and the use of various separation techniques, retainers, and bands.

Aims: The aim of this study was to evaluate the proximal contact tightness that is achieved by various matrix systems used to restore a direct Class II cavity with composite resin restoration.

Methods: A systematic review was carried out according to the PRISMA 2020 statement guidelines. The online search for the articles was done in electronic databases of MEDLINE/PubMed, Cochrane, and Google Scholar. The articles comparing different matrix systems for restoration were selected. Out of 146 articles, a total of 6 articles met the selection criteria and were included. The QUIN risk-of-bias (RoB) tool was used for assessing the study quality. The data extracted from full text articles selected for inclusion, using a standardized software (Office Excel 2013 Software, Microsoft Corporation, Redmond, WA, USA).

Results and Conclusion: Combination of sectional matrices and separation rings resulted in tighter proximal contact compared to other matrix systems.

Keywords: Circumferential matrix; Class II composite; matrix systems; proximal contact tightness; sectional matrix

INTRODUCTION

Tooth-colored restorative materials have been used for posterior restorations to replace metallic restorations. Improved properties and increased esthetics have made direct composite resin material of choice by various dental schools.[1,2] Restoring an ideal proximal contact in direct Class II composite resin restorations is a challenge due to polymerization shrinkage, absence of condensability of composite materials, thickness of matrix bands, and the use of various separation techniques, retainers, and bands.[3-6] A faulty proximal contact may lead to food impaction, periodontal complications, tooth migration, and carious lesions.[7,8]

Obtaining an interdental separation during placement of the composite restoration is a key factor in producing a tight proximal contact and several matrix systems are available in the market which provide various degrees of interdental separation. These include precontoured matrices, circumferential matrix systems with metal or transparent plastic bands, and sectional matrix systems with separation rings.[9-11] However, the proximal contact tightness (PCT) might change over time.

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Studies have been done to compare various matrix systems on PCT. Peumans *et al*.[4] in an *in vitro* study found that tightness of the proximal contact of a Class II 2-surface resin composite restoration was looser with a circumferential matrix system than with a sectional matrix in combination with a separation ring and the same result was obtained in an *in vivo* study done by Loomans *et al*.[12] Cardoso *et al*.[13] in a study comparing different techniques for establishing proximal contacts in posterior composite restoration concluded that there was no difference in the technique used. El-Shamy[14] compared metal versus transparent matrices and found that sectional metal matrices produced proper PCT. There is a need to examine the literature on various matrix systems used for establishment of proper proximal contacts.

The aim of this study is to perform a qualitative systematic review to evaluate the PCT of direct Class II composite resin restorations with various matrix systems. The null hypothesis was that there would be no difference in PCT when different matrix systems were used.

METHODS

Data sources

This systematic review is registered in PROSPERO (ID-CRD42022372529) and reported in accordance with the PRISMA 2020 statement guidelines. The online search for the articles was done in electronic databases of MEDLINE/PubMed, Cochrane, and Google Scholar. The search was restricted to English language. The search strategy is presented in Table 1. The search and selection of studies were performed between the years 2000 and 2023. The last search was performed on September 30, 2023.

Table 1 : Electronic databases and search strategies

Database	Keywords
Medline/ PubMed	((“dental composite resin”[TIAB] OR “composite resin”[TIAB]), AND (“proximal contact tightness”[TIAB] OR “proximal contact strength”[TIAB]) AND “class II composite”[TIAB] OR “direct class II composite” [TIAB]) AND (“matrix system for class II composite”[TIAB] OR “proximal matrix system for composite” [TIAB]))
Cochrane	((TITLE-ABS-KEY (“dental composite resin”) OR TITLE-ABS-KEY (“composite resin”)), (TITLE-ABS-KEY (proximal contact tightness) OR TITLE-ABS-KEY (proximal contact strength), (TITLE-ABS-KEY (“class II composite” OR TITLE-ABS-KEY (“direct class II composite”), (TITLE-ABS-KEY (“matrix system for class II composite” OR TITLE-ABS-KEY “proximal matrix system for composite”)
Google Scholar	((TITLE-ABS-KEY (“dental composite resin”) OR TITLE-ABS-KEY (composite resin)) AND (TITLE-ABS-KEY (proximal contact tightness) OR TITLE-ABS-KEY (proximal contact strength), (TITLE-ABS-KEY (“class II composite” OR TITLE-ABS-KEY (“direct class II composite”), (TITLE-ABS-KEY (“matrix system for class II composite” OR TITLE-ABS-KEY “proximal matrix system for composite”)

Resources selection

The articles were reviewed by two authors (KA and BV) independently. The articles were selected if they had the following inclusion criteria: class II cavities on at least one proximal surface of premolars or molars restored with direct composite resin restoration using various matrix systems and PCT tested through standard technique and expressed in Newton (N). The study included *in vitro* studies both on extracted and artificial (ivorine/typodont) teeth. The exclusion criteria were teeth restored with indirect restorations, restorative materials other than composites, single matrix system, randomized control trials, and observational studies. The full-text articles were reviewed for the inclusion and exclusion criteria by both the authors, and the disagreement that arouse during selection of article was resolved by the third author (SSY).

Data extraction

The data extraction was defined and performed by one author (KA) and reviewed by a second author (BV) using a standardized protocol. The data were extracted from full-text articles selected for inclusion using a standardized software (Office Excel 2013 Software, Microsoft Corporation, Redmond, WA, USA). The following data were extracted from the articles: author, publication year, sample size, type of tooth used, type of cavity preparation, type of composite resin, type of matrix system, and PCT (measured in N).

Risk of bias assessment

The risk of bias assessment (RoB) was done by QUIN tool[15] by two researchers independently (KA and BV). The QUIN tool assesses the studies under 12 criteria namely, aim/objective statement, sample size calculation, sampling technique, comparison group details, methodology explanation, operator details, randomization, outcome assessor details, measurement of outcome, blinding, statistical analysis, and results. The studies were rated according to ‘adequately specified’ (score = 2), ‘inadequately specified’ (score = 1), or ‘not specified’ (score = 0). Scores were subsequently added and the RoB of the study was estimated using;

$$\text{RoB} = \frac{\text{Total score} \times 100}{\text{2X applicable criteria}}$$

Studies were then graded according to their RoB as high (<50%), medium (between 50 and 70%) or low risk (>70%).

RESULTS

A total of 146 relevant records were found in the three databases searched. A flowchart summarizing the selection process of article as per PRISMA guidelines 2020 is shown in Figure 1. After exclusion of the duplicates, examining the titles, abstracts, and full-text articles, a total of six articles

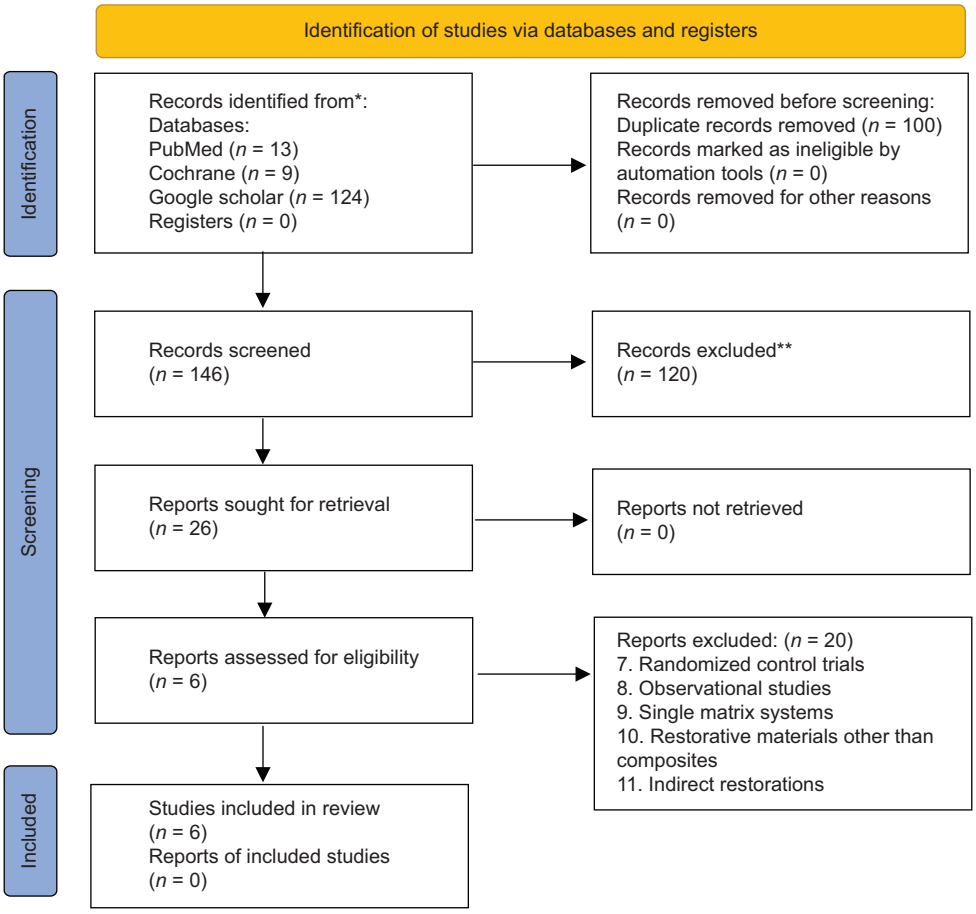

Figure 1: PRISMA 2020 flowchart. *Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). **If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools. For more information, visit: http://www.prisma statement.org[16]

were selected as per the inclusion and exclusion criteria defined. The studies included and the variables collected are shown in Table 2. In the included studies, it can be seen that the proximal contact tightness was more for sectional matrix systems ranging between 4.01 – 11.07 N, in comparison with other matrix systems used. RoB analysis graded two studies of having low risk and four studies of medium risk of bias, most studies displayed inadequate description of the sample size calculation, operator details, randomization, outcome assessor details and blinding [Table 3].

DISCUSSION

The present systematic review established the pooled effect of the data from *in vitro* studies that assessed the PCT of Class II direct composite resin restorations when various matrix systems were used. This study provides a guide to selection of matrix systems when restoring a Class II cavity with composite resin. The overall result showed that sectional matrix systems with a separation ring and circumferential matrix systems with a separation ring established tighter proximal contacts. The null hypothesis of the present study was rejected as matrix systems without separation ring gave less values for PCT.

Loomans *et al*.[19] in their study showed that the use of a separation ring combined with either sectional matrix or circumferential matrix resulted in tighter proximal contacts independent of the composite material and the thickness of the matrix band used which was also in accordance with the study done by Saber *et al*.[10] In contrast, El-Shamy *et al*.[18] have found that bulk-fill packable composites produced tighter contacts when compared to flowable composites irrespective of the placement technique used. In another study by Loomans *et al*.,[20] they found a statistically significant difference when flexible matrices were used in comparison to dead soft matrix. The probable reason could be, after insertion of matrix and placement of separation ring, the flexible matrix preserved the pre-contoured proximal form resulting in tighter contact. Whereas, dead-soft matrix due to matrix deformation, sometimes produced negative contour of the proximal area. Further, El-Shamy[14] also has shown that proper PCT for bulk-fill composite restorations can be produced by sectional metal matrix rather than transparent matrix.

Table 2: Summary of the selected articles Distinct superscripts (a, b, c, d, e, and f) represent statistically significant differences between groups ($P<0.05$)

Author and year	Type of teeth	Type of cavity	Type of composite used	Matrix system used	Results
Tolba *et al*. (2023)[17]	20 artificial teeth #36	20 MO standardized cavity preparations	Tetric N-Ceram nano-hybrid composite, Ivoclar Vivadent, Liechtenstein	1. Sectional matrix system and a separation ring (Palodent V3, Dentsply Sirona, USA) 2. Circumferential matrix system with integrated tightener (Palodent 360, Dentsply Sirona, USA)	1. 4.22[a] 2. 3.03
El-Shamy *et al*. (2019)[18]	150 artificial teeth #36	150 MO standardized cavity preparations	a. Smart dentin replacement b. SonicFill system c. Tetric EvoCeram Bulk-Fill d. G-ænial Universal Flo e. Tetric EvoCeram, Ivoclar Vivadent, Liechtenstein	1. Dixieland band (Waterpik) + Tofflemire retainer 2. FenderMate stainless steel sectional matrix 3. Palodent plus system; sectional contoured dead-soft matrix + BiTine separation ring (Dentsply)	1.a. 1.75[b] 1.b. 3.21[c] 1.c. 3.06[c] 1.d. 2.49[a] 1.e. 3.18[c] 2.a. 1.87[b] 2.b. 3.35[c] 2.c. 3.17[c] 2.d. 2.64[a] 2.e. 3.26[c,d] 3.a. 3.16[c] 3.b. 4.23[e] 3.c. 4.1[e,f] 3.d. 3.46[d] 3.e. 3.98[e,f]
El-Shamy (2018)[14]	80 artificial teeth #36	80 MO standardized cavity preparations	SonicFill 2 (Kerr Corporation)	1. Sectional metal matrix (standard matrix, Palodent) 2. 1101c-matrix + Tofflemire (Kerr) 3. Conventional metal matrix (Hawe Tofflemire matrices) + Tofflemire (Kerr) 4. Blue Cure-Thru transparent contoured matrix band (Premier Dental Products)	1. 7.62[a] 2. 4.01[b] 3. 4.13[b] 4. 2.74[c]
Saber *et al*. (2010)[10]	105 artificial teeth #36	105 MO standardized cavity preparations	Premise, Kerr Corporation	1. Composi-Tight Silver Plus matrix and separation ring 2. 1101c-matrix + Tofflemire (Kerr) + separation ring (Composi-Tight Silver Plus) 3. 1101c-matrix + Tofflemire (Kerr) 4. 1101c-matrix + Tofflemire (Kerr) + OptraContact, Ivoclar Vivadent 5. 1101c-matrix + Tofflemire (Kerr) + medium Class II ceramic insert (Cerana) 6. 1101c-matrix + Tofflemire (Kerr) + Elliot separator (Pfingst and Co) 7. O-form #10 Walser matrix (Dr. Walser Dental)	1. 6.64d 2. 4.01[c] 3. 0.38[a] 4. 0.91[a,e] 5. 2.99[b] 6. 4.29[c] 7. 1.34[e]
Loomans *et al*. (2006)[19]	360 artificial teeth #36	360 MO standardized cavity preparations	a. X-Flow (A3) Dentsply Caulk b. Clearfil I AP-X (A3) Kuraray Medical c. Tetric Ceram HB (A3) Ivoclar Vivadent	1. 1101-c matrix (KerrHawe) + Tofflemire retainer 2. 1101-c matrix (KerrHawe) + Tofflemire retainer + separation ring (Composi-Tight Gold) 3. Lite-Flex matrix (Danville materials) + separation ring (Composi-Tight Gold) 4. Adapt SuperCap matrix (KerrHawe) 5. Adapt SuperCap matrix (KerrHawe) + separation ring (Composi-Tight Gold)	1.a. 5.20[b] 1.b. 6.73[c] 1.c. 6.80[c] 2.a. 7.12[c,d] 2.b. 9.39[d,e] 2.c. 11.07[f] 3.a. 7.17[c,d] 3.b. 8.18[d] 3.c. 10.45[e,f] 4.a. 3.98[a] 4.b. 4.48[a,b] 4.c. 5.78[b,c] 5.a. 5.67[b,c] 5.b. 10.90[e,f] 5.c. 9.70[e]
Loomans *et al*. (2006)[20]	160 artificial teeth #36	160 MO standardized cavity preparations	Clearfil AP-X; Kuraray Medical	1. Tofflemire + circumferential No. 1 X-thin matrix (Products D) 2. Tofflemire + circumferential precontoured 1001-c matrix (Hawe Neos) 3. Separation ring (Composi-Tight Gold) + Thin Flex matrix (Danville Mat.) 4. Separation ring (Composi-Tight Gold) + standard matrix (Dentsply) 5. Separation ring (Composi-Tight Gold) + Thin Flex matrix (Danville Mat.) 6. Separation ring (contact matrix system) + standard matrix (Dentsply) 7. Separation ring (Palodent BiTine) + Thin Flex matrix (Danville Mat.) 8. Separation ring (Palodent BiTine) + standard matrix (Dentsply)	1. 2.89[a] 2. 3.42[a] 3. 8.86[d] 4. 7.13[b,c] 5. 6.60[b,c] 6. 6.07[b] 7. 8.02[c,d] 8. 5.67[b]

Table 3: Risk of Bias assessment of the studies included

Study	Clearly stated Aims/ Objectives	Detailed explanation of sample size Collection	Detailed explanation of sampling technique	Details of Comparison group	Details of Methodology	Operator details	Randomization	Method of measurement of outcome	Outcome assessor details	Blinding	Statistical analysis	Results	Score	Bias evaluation (Score × 100/2 x number of criteria applicable	Risk
Zeinab Omar Tolba *et al.* (2023)[17]	2	2	2	2	2	0	1	2	1	0	2	2	18	75	Low Risk
El-Shamy *et al.* (2019)[18]	2	2	1	2	2	0	1	2	1	1	2	2	18	75	Low Risk
El-Shamy (2018)[14]	2	0	0	2	2	0	1	2	0	0	2	2	13	54.1	Medium Risk
Saber *et al.* (2010)[10]	2	0	0	2	2	0	0	2	1	0	2	2	13	54.1	Medium Risk
Loomans *et al.* (2006a)[19]	2	0	0	2	2	0	0	2	0	0	2	2	12	50	Medium Risk
Loomans *et al.* (2006b)[20]	2	0	0	2	2	0	0	2	0	0	2	2	12	50	Medium Risk

A randomized clinical trial done by Loomans *et al*.[12] showed that Class II posterior composite resin restorations placed with a combination of sectional matrices and separation rings resulted in a stronger proximal contact than when a circumferential matrix system was used. An *in vivo* study conducted by Wirsching *et al*.[21] too demonstrated the superior PCT with sectional matrix combined with separation rings. The circumferential matrix band when placed doubles the thickness of the matrix that has to be compensated as it passes through both the contacts as opposed to a sectional matrix band that is placed only at the proximal contact that has to be restored. To compensate for this increased thickness, greater separation is required. Separation rings create separation force vectors at the height of the proximal contact, which remains stable as long as the ring remains activated, while wedges produce elongation and/or rotation rather than real separation.[10]

The risk of bias assessment showed that the studies included had a medium and Low risk of bias and these studies likely did not control all the variables that could influence the results. The main limitation of the present systematic review is that it included only *in vitro* studies with controlled variables and environment. The PCT was evaluated just after restorative procedure, and the aging of the restoration under different oral environmental conditions was not considered which may have had the influence. Moreover, *in vivo* studies also need to be conducted to study the long-term maintenance of the PCT achieved.

CONCLUSION

Within the limitations of this study, it can be concluded that,

- Separation ring either in combination with sectional matrix or circumferential matrix produced tighter proximal contacts
- Metal matrices were better than transparent matrices.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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