

# Creating Tight Proximal Contacts for MOD Resin Composite Restorations

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## Clinical Relevance

Matrix placement and separation of both proximal surfaces should be performed simultaneously prior to placement of the resin composite in MOD cavities.

## SUMMARY

**Objective:** The purpose of this study was to compare proximal contact tightness (PCT) of

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MOD resin composite restorations placed with different matricing protocols.

**Methods:** Forty-five ivorine lower right first molars with standardized MOD cavities were equally divided into three groups according to the restoration protocol. Group 1: Sectional matrix (Standard matrix, Palodent, Dentsply) secured with a wedge (Premier Dental Products Co.) and separation ring (BiTine I, Palodent, Dentsply, York, PA, USA) was used to restore the mesial surface first and then removed and repeated for the distal surface. Group 2: Identical to group 1, but separation rings were placed at both the mesial and distal sides (BiTine I+II, Palodent) prior to restoration. Mesial surface was restored followed by distal. Group 3: Walser matrix (O-form, Dr. Walser Dental GmbH) was used. Following composite resin restoration, PCT was measured using the tooth pressure meter. Data were analyzed using analysis of variance and a Tukey *post hoc* test ( $p < 0.05$ ).

**Results:** PCT values for mesial contacts were  $2.99 \pm 0.47\text{N}$  for group 1,  $4.57 \pm 0.36\text{N}$  for group 2, and  $3.03 \pm 0.79\text{N}$  for group 3. For the distal contacts, the values were  $4.46 \pm 0.44\text{N}$  for

group 1,  $5.12 \pm 0.13\text{N}$  for group 2, and  $0.76 \pm 0.77\text{N}$  for group 3. Significantly tighter contacts were obtained for mesial and distal contacts for group 2 compared to groups 1 and 3 ( $p < 0.05$ ). For groups 1 and 3, mesial contacts were not significantly different ( $p = 0.993$ ), while distal contacts for group 1 were significantly tighter ( $p < 0.001$ ).

**Conclusion:** Within the limitations of this study, tighter contacts can be obtained when sectional matrices and separation rings are applied to both proximal surfaces prior to placement of the resin composite in MOD cavities.

## INTRODUCTION

Class II cavity preparations, specifically those involving both proximal surfaces of one tooth, are regarded by clinicians as one of the most challenging situations. A wide variety of treatment modalities are indicated for the restoration of teeth with MOD cavities, ranging from direct fillings using amalgam or resin composite to the more elaborate indirect restorations,<sup>1</sup> each with its own indications, advantages, problems, and challenges. When restoring the proximal contact, the reconstruction of correct anatomical contour as well as the provision of appropriate proximal contact tightness is essential for periodontal health.<sup>2-5</sup> Failure to obtain tight proximal contacts can cause food impaction, resulting in caries or periodontal disease and possible movement of teeth.<sup>2,6,7</sup>

With the increasing popularity of resin composite as a direct posterior restorative material, issues with the reconstruction of the proximal contact have emerged. Unlike its metallic counterpart, amalgam, resin composite is viscoelastic in nature, cannot be condensed into the cavity, and undergoes polymerization shrinkage during curing.<sup>8,9</sup> These drawbacks, in combination with the elasticity and thickness of the matrix band, make reconstruction of tight proximal contacts a difficult task.<sup>10</sup> In an attempt to provide tighter and more anatomic proximal contacts, several techniques and instruments have been proposed.<sup>5,8,11,12</sup> The application of heavy wedging was advocated but failed to promote a tight proximal contact.<sup>13</sup> Another study by Loomans and others found “pre-wedging” to have an insignificant effect on interdental separation.<sup>14</sup> Also, convex-pronged instruments designed to create a resin composite bridge to support the matrix band at the contact area during curing showed limited success.<sup>13,15</sup> Several studies unsubstantiated claims

that high-viscosity resin composite produces tighter proximal contacts.<sup>9,15-17</sup> When the effect of matrix band type on proximal contacts was investigated, the performance of transparent bands was found to be comparable to that of metal bands.<sup>18,19</sup> Precontoured matrix bands demonstrated superior contours when compared to flat matrix bands.<sup>17,20</sup> All the studies conclude that the key factor is the provision of interdental separation. Separation rings create the most interdental separation to compensate for matrix thickness and material properties, and this explains the tight proximal contacts achieved when such rings are combined with precontoured sectional matrices.<sup>10,14,15,21-24</sup> However, the results of these studies were based on two-surface resin composite restorations with little information available in the literature regarding the best techniques to reconstruct three-surface MOD resin composite restorations.

Some clinicians advocated application of matrices, separation, and restoration of each proximal surface independently.<sup>10</sup> Others recommended matrix application and separation at both proximal areas simultaneously.<sup>10</sup> A new matrix system, Walser matrix, specifically designed for multisurface restorations, was also recently introduced. The system consists of 25 different self-clamping matrices to enable restoration of a wide variety of proximal lesions in all teeth. The matrix bands are supplied attached to a spring mechanism that enables them to wrap around the teeth in a corset-like fashion. Unlike other systems, they are placed as a single component, and the manufacturer claims that wedging is not necessary. However, the literature lacks conclusive evidence regarding the contact tightness achieved by any of these techniques.

Based on this premise, the aim of the study was to compare the proximal contact tightness obtained when three matrix placement protocols were used to place three-surface MOD resin composite restorations.

## MATERIALS AND METHODS

A mesio-occluso-distal cavity was prepared in an ivory lower right first molar (Kilgore International, Coldwater, MI), producing a master model. The occlusal portion of the cavity was 4 mm wide and 3 mm deep. The measurements of the mesial and distal proximal boxes were 5 mm buccolingual width, 4 mm occlusogingival height, and 1.5 mm mesiodistal depth. The model was sent to the manufacturer for duplication to provide 45 identical MOD cavity preparations. Prepared teeth were then randomly

divided into three groups (n=15) and restored according to the following protocols:

Group 1: Restored using a sectional matrix (Standard matrix, Palodent, Dentsply, York, PA, USA) stabilized using a wooden wedge (Premier Dental Products Co., Plymouth Meeting, PA, USA) and a separation ring (BiTine I, Palodent). Matrix assembly was placed on the mesial box of the cavity first, followed by restoration of this portion of the cavity. The matrix assembly was removed and transferred with a fresh matrix band to the distal box, which was then restored. The MOD restoration was then finalized with an occlusal increment.

Group 2 (Control): Restored using the same matrix assembly as in group 1; however, matrices were placed simultaneously at the mesial and distal boxes. The restoration was first placed in the mesial portion, then the distal portion, and was then finalized with an occlusal increment.

Group 3: Restored using the circumferential Walser matrix O-form no. 10 (Dr. Walser Dental GmbH, Radolfzell, Germany). The matrix was placed around the tooth, without wedges or any other separation device as recommended by the manufacturer. The restoration sequence was identical to group 2 (Figure 1).

Prior to adhesive procedures, the contact area was carefully burnished with a hand instrument (PFI 49, Dentsply Ash, Weybridge, Surrey, United Kingdom) so that no visual space was left between the matrix and the adjacent teeth. The adaptation of the matrix band at the gingival cavity margin was checked with an explorer (Dentsply Ash). The adhesive (OptiBond All-in-one, Kerr Corp, Orange, CA, USA) was applied according to the manufacturer's instructions and polymerized with a halogen polymerization unit for 10 seconds (QHL75 lite, Dentsply) at a light intensity of 450 mW/cm<sup>2</sup>. Resin composite TPH 3 (Dentsply) was placed and adapted tangentially using a hand instrument (OptraSculpt, Ivoclar Vivadent, Liechtenstein) in three increments: a horizontal gingival, a tangential buccal, and finally a tangential lingual increment. Each layer was separately cured for 20 seconds from the occlusal direction. The procedure was repeated for both proximal portions of the prepared cavity.

All the above restorative procedures were performed by one operator on a manikin (Kilgore International) mounted in a manikin head (KaVo Dental, Biberach, Germany) in order to simulate clinical conditions. The adjacent lower right second premolar and second molar were replaced with

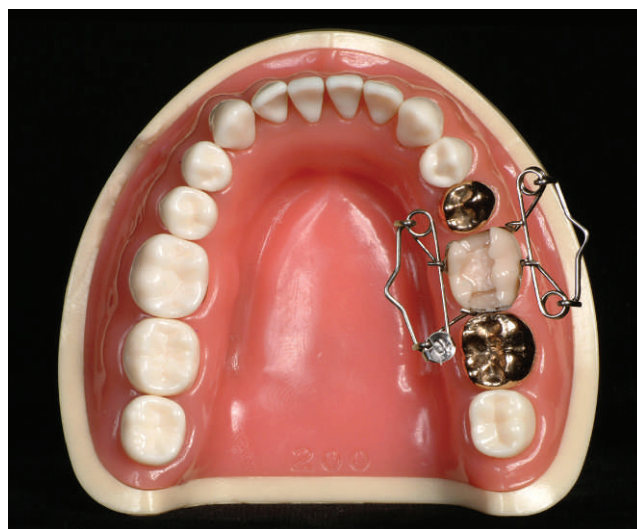


Figure 1. Walser matrix O-type no. 10 used to restore and MOD cavity preparation.

copper-zinc alloy cast replicas in the manikin to prevent wear during proximal contact measurement procedures.<sup>15</sup> Careful examination of contact areas was performed after matrix removal. If necessary, judicious finishing of embrasures, away from the contact area, was performed using fine abrasive finishing discs (Sof-Lex, 3M ESPE, St. Paul, MN, USA) to ensure optimal contact measurement.

Proximal contact tightness was measured using the tooth pressure meter (TPM), as described by Loomans and others.<sup>23</sup> The TPM and manikin were mounted in a custom-made stand to ensure a standardized near-parallel insertion and withdrawal of the metal measuring strip into the contact for all measurement procedures (Figure 2). A similar setup has been shown to produce clinically relevant results in previous studies.<sup>23,24</sup> Proximal contact tightness (PCT) for all restorations was measured immediately after placement using the TPM. The TPM measures the proximal contact tightness as the maximum frictional force (N) exerted on a 0.05-mm-thick metal strip on withdrawal from the interproximal area in an occlusal direction. Three measurement procedures were performed for each contact area. The final result of each measurement was the mean of these three consecutive measurements. A measurement failed when the outcome exceeded the maximum (preset) range of 0.5N between the three measurements, such as due to deformations of the strip or a nonparallel removal of the strip from the interdental area. This measurement was then excluded from the analysis and repeated. Metal strips were examined for visible defects before each



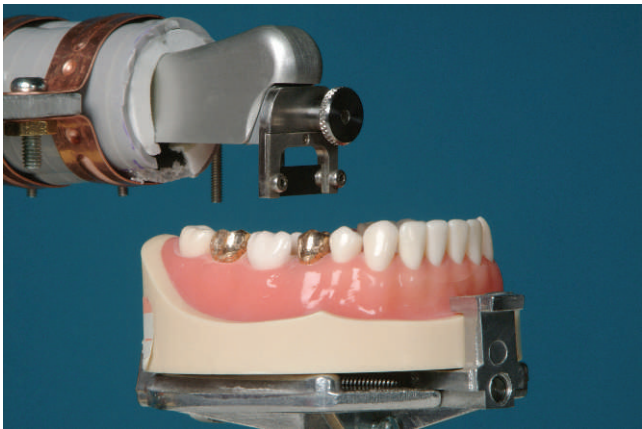


Figure 2. Tooth pressure meter mounted in a custom rig to standardize measurement procedures.

measurement and replaced accordingly. Custom-written software in Excel (MS Office 2000, Windows) was used for data acquisition and for construction of diagrams, relating force to seconds.

Data were analyzed using SPSS 15 (SPSS Inc, Chicago, IL, USA). One-way analysis of variance followed by a Tukey *post hoc* test were used to identify statistical differences between pairs of means. Statistical significance was set at  $p<0.05$  for all tests.

RESULTS

The means, standard deviations, and 95% confidence interval (95% CI) of the three techniques used to restore the proximal contact are outlined

in Table 1 and Figure 3. For group 1, where one separation ring was applied at a time, PCT values were  $2.99 \pm 0.47\text{N}$  and  $4.46 \pm 0.44\text{N}$  for mesial and distal contacts, respectively. However, the application of two separation rings simultaneously in the control group resulted in a statistically significant increase in PCT values for both the mesial ( $4.57 \pm 0.36\text{N}$ ) and distal ( $5.12 \pm 0.13\text{N}$ ) contacts compared to group 1 ( $p<0.001$  and  $p=0.047$ , respectively). As for group 3, the mesial PCT value was  $3.03 \pm 0.79\text{N}$ , which was comparable to the mesial PCT value for group 1 ( $p=0.993$ ) but significantly lower than the mesial PCT value for the control group ( $p<0.001$ ). As for the distal contact for group 3, a PCT value of  $0.76 \pm 0.77\text{N}$  was observed, which is significantly the lowest PCT value recorded within all the tested groups ( $p<0.001$ ). Moreover, the mesial proximal contact for group 3 was significantly tighter than the distal one ( $p<0.001$ ). On the contrary, the distal contacts in group 1 and the control were significantly tighter than the mesial contacts ( $p<0.001$ ).

DISCUSSION

Prior to discussing the results, it must be reiterated that the aim of the study was to evaluate three different strategies for matrix application prior to resin placement in MOD-prepared cavities. The individual aspects of matrix systems, such as band thickness and wedging as they relate to proximal contact, were previously investigated.<sup>15</sup> Based on the results of this study, it can be discerned that the

Table 1: Statistical analysis of the proximal contact tightness in the different study groups				
Group	Mean (N) <sup>a</sup>	Standard Deviation	95% Confidence Interval	
			Lower Bound	Upper Bound
Group 1 mesial	2.99 A	0.47	2.60	3.39
Group 1 distal	4.46 B	0.44	4.09	4.82
Group 2 mesial	4.57 B	0.36	4.27	4.88
Group 2 distal	5.12 C	0.13	5.01	5.22
Group 3 mesial	3.03 A	0.79	2.37	3.69
Group 3 distal	0.76 D	0.77	0.11	1.40
<sup>a</sup> Means that are statistically significantly different at $p<0.05$ are marked with different characters (A-D).				

concurrent application of two separation rings maximized the amount of separation obtained, eventually resulting in tighter contacts in the case of direct MOD resin composite restorations. This might be due to the simultaneous spread of the separation forces both mesial and distal to the tooth to be restored. This pattern of force distribution may have prevented the prepared tooth from moving in either direction, and this would result in a reduction of the interdental space. In fact, the simultaneous application of separating forces appears to have moved the adjacent teeth away from the prepared tooth. As a result, a greater compensation for matrix band thickness was achieved, resulting in tighter contacts. An additional clinical advantage for applying matrix to both sides simultaneously is the isolation of working field. The matrix band and wedge in clinical situations act as a barrier that prevent the seepage of saliva, sulcular fluids, or blood into the proximal cavity portion, even in the presence of a rubber dam, especially in deeper gingival seat locations. However, in cases of gingival inflammation or periodontal disease, the application of a wedge and matrix may result in bleeding and, if not controlled, may result in unsuccessful bonding. Hence, when matrices are applied simultaneously to both proximal boxes prior to restoration, bleeding from the papilla will not be able to access the cavity.<sup>25</sup> A noteworthy aspect is the decision by the authors not to use amalgam as a test material. Amalgam was shown to produce tighter proximal contacts compared to resin composite.<sup>16</sup> Moreover, the use of amalgam with separation rings will result in excessive contact tightness, leading to the fracture of amalgam during matrix removal. Thus, the sole focus of this study was resin composite.

Clinically, the intra- and interindividual variation in contact tightness is very large, and therefore an optimal value for contact tightness cannot be given.<sup>17,26</sup> According to these studies, no inconveniences were reported when the proximal contact tightness was changed. Other clinical studies demonstrated that absent or too loose proximal contacts can lead to food impaction, tooth migration, periodontal complications, and carious lesions.<sup>4,5</sup> On the contrary, too tight proximal contacts may hamper passing dental floss through the contact area, causing inconveniences and periodontal problems.<sup>7,27</sup> Moreover, a quantitative analysis of the proximal contact tightness demands the measurement of the difference between contact tightness before and after treatment. In an *in vitro* model, only the contact tightness after treatment

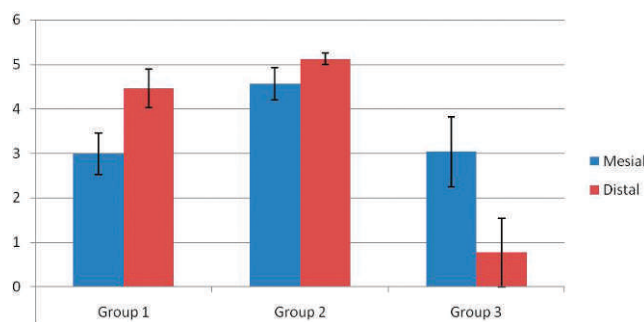


Figure 3. Mean ( $\pm$ SD) contact tightness (N) for the different study groups.

can be measured. Therefore, the values of contact tightness obtained with an *in vitro* model cannot be directly translated into clinical values. Therefore, the main purpose of this *in vitro* model is to compare different systems and techniques with each other.<sup>23</sup>

Proximal contact tightness is proportional to the amount of interdental separation achieved. This may explain the significantly tighter distal contact in the control group, where the distal surface was separated for a longer time compared to the mesial surface, as it was restored after the mesial surface. The Walser matrix achieved a relatively stronger proximal contact on the mesial side, which was the last to be restored. The system seems to provide insufficient interdental separation and relies mainly on adaptation of the matrix band to the neighboring tooth. In addition, the Walser matrix bands are thicker compared to sectional matrix bands (0.05 mm as opposed to 0.03 mm). This somewhat increased thickness might also contribute to the weaker contacts achieved by the Walser matrix. However, because of the relatively rigid attachment of the teeth, it cannot be excluded that the Walser matrix might be more efficient in clinical situations with weaker physiological contacts. Moreover, the authors found that the Walser matrix system was difficult to apply, as it required passage of the two matrix bands concurrently through the mesial and distal contacts as well as the soft flexible nature of the retainer itself. This problem does not exist when using sectional matrices, as both matrices are placed successively. On the other hand, the Walser matrix seems to adapt seamlessly to the conical tooth form, as the band fits tightly under tension to the external margins of the proximal box without a wedge. Further investigations are required to determine the performance of this system in a clinical setting

with regard to marginal overhang, proximal contact, and contour. Whether the combination of the Walser matrix with separation rings can provide an alternative for successful matricing of class II cavity preparations requires further investigation.

## CONCLUSIONS

Under the conditions of this *in vitro* study, it was concluded that in three-surface Class II MOD resin composite restorations, tighter proximal contacts were obtained when separation rings and sectional matrix bands were applied simultaneously for both proximal surfaces. A newer matrix/separation system did not produce comparable tight proximal contact to the above assembly.

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