Influence of matrix systems on proximal contact tightness of 2- and 3-surface posterior composite restorations in vivo

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ABSTRACT

Objectives: To investigate the influence of cavity preparation (MO/DO/MOD) and type of matrix system on proximal contact tightness of direct posterior composite restorations.

Materials and methods: 85 patients in need of a two- or three surface Class II direct composite restoration were randomly divided into two treatment groups. Group 1 was treated with a sectional matrix system combined with a separation ring (Palodent); Group 2 was treated with a circumferential matrix system in combination with a retainer (Tofflemire). Proximal contact tightness was recorded before treatment and directly after finishing the restoration.

Results: For the two-surface cavities use of the separation ring resulted in a statistically significantly tighter proximal contacts at both the mesial and distal site (MO: 2.51 ± 0.81 N; DO: 2.82 ± 1.14 N) compared to the use of the circumferential (MO: –1.08 ± 1.04 N; DO: –0.22 ± 0.87 N) (p = 0.01). Regarding the three-surface (MOD) cavities no statistically significant differences were found between the mesial and distal site, nor was there an effect of the used matrix system. No statistically significant influence of cavity design (mesially/distally) was recorded for all cavities (MO, DO and MOD).

Conclusions: Use of the sectional matrix system in two-surface Class II cavities resulted in statistically significantly tighter proximal contacts than the use of the circumferential matrix system.

For the three-surface no statistically significant differences in contact tightness were found between the different matrix systems.

Location of the cavity (mesially or distally) did not show to have any statistically significant effect on the obtained proximal contact tightness.

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1. Introduction

Creating tight anatomic correct proximal contacts still remains difficult when placing direct posterior restorations. This problem is based on several potential mechanisms, including that composite cannot be ‘condensed’ as can amalgam, which leads to an insufficient adaptation of the matrix towards the adjacent tooth, the polymerization shrinkage of the composite material and the effects on the tooth position due to the elastic behaviour of the rubber-dam.1–3

The proximal contact plays an important role in the stomatognathic system. An inadequate contact may lead to food impaction, periodontal diseases and can cause tooth movements.4–6 Therefore, research has tried to overcome
existing problems by improving material characteristics and application techniques. In this context, the choice of the matrix system and separation technique is an important factor. In present dentistry, traditional circumferential matrix systems are used popularly, but show shortcomings regarding the creation of tight proximal contacts and their improper proximal matrix form.7

Against this background new alternative matrix systems have been introduced. In recent in vitro and in vivo studies, sectional matrix systems in combination with separation rings proved to generate proximal contact with a reliable tightness in two-surface Class II-cavities.8–11

It was shown that when placing Class II resin composite restorations the use of sectional matrix systems and separation rings resulted in tighter proximal contacts than when traditional circumferential matrix systems, without separation rings, are applied.8–11 These results are applicable for the two-surface preparations, however, the effectiveness for three-surface Class II cavities is unknown. Moreover, the difference between the MO and DO two-surface restorations in the creation of tight proximal contacts is not clear.

The circumferential matrix systems showed significant looser proximal contacts in previous mentioned studies for Class II cavities, which might be explained by the thickness of the matrix when placing a two-surface restoration. In case of MOD restoration no clinical data of the resulting proximal contact tightness are available. Therefore, the aim of the present study was to investigate proximal contact tightness of three-surface MOD Class II cavities, restored with a circumferential matrix system and to investigate if there is an influence of cavity localisation (MO/DO) on proximal contact tightness.

2. Materials and methods

This randomized clinical trial was performed at the Clinic for Conservative Dentistry and Periodontology. 85 patients in need of a two- or three surface Class II direct composite resin restoration participated the study. Inclusion criteria were good general health, minimum age of 18 and fully erupted occluding teeth. Exclusion criteria were severe periodontal diseases, diastema between posterior teeth, presence of fixed partial dentures and tooth mobility more than score 1.

All restorations were placed by students of the Clinic for Conservative Dentistry. 44 males and 41 females at the average age of 41 ± 15.1 years qualified for participating. All restorations were placed under rubberdam (Hygienic Corporation, OH 44310, USA) over the whole quadrant in which the restoration were placed under rubberdam (Hygienic Corporation, OH 44310, USA) over the whole quadrant in which the final result of a single measuring site is the mean value of three measurements. Custom-written software in Excel (MS Office 2000, Windows) is used for data acquisition and for construction of diagrams, relating force (N) to seconds (sec.). At each measuring site three measurements were taken, of which outcomes should be within a maximum range of 0.5 N. Measurement outcomes exceeding this range or presence of visible irregularities in the diagram, e.g. due to deformations of the strip, excluded data for analysis and leads to repetition of the measurement. The final result of a single measuring site is the mean value of these three outcomes.

Proximal contact tightness was recorded before treatment (T0) and directly after finishing the restoration (Tf). Proximal contacts were measured at five proximal contacts: both contacts of the restored tooth (mesial and distal contact) as well as an additional contact in mesial direction of the same quadrant. The corresponding contacts in the contra-lateral quadrants were also measured and were taken as control to
register changes in contact tightness, which were not related to the treatment.

Statistical analysis was performed with the statistical software package SPSS 12.01 (SPSS Inc., Chicago, IL 60606, USA). After testing the data for normal distribution with the Kolmogorov-Smirnov/Lilljefors tests, mean values and standard deviations of the contact tightness in both groups were calculated. The comparisons of the mean differences between the two groups were tested for statistical significance with the T-test for independent variables. Differences of contact tightness within one patient were calculated with the one-way ANOVA and post hoc with the Schefte test. The significance level was set at \( p < 0.05 \).

### 3. Results

In Fig. 1 the recorded mean difference \( (T_1 - T_0) \) of proximal contact tightness with the standard error of the mean is presented, between before beginning of the treatment and directly after finishing the restoration.

For the two-surface cavities use of the separation ring resulted in a statistically significantly tighter proximal contacts at both the mesial \( (2.51 \pm 0.81 \text{ N}) \) and distal site \( (2.82 \pm 1.14 \text{ N}) \) compared to the use of the circumferential matrix system \( (\text{mesial: } -1.08 \pm 1.04 \text{ N}; \text{distal: } -0.22 \pm 0.87 \text{ N}) \) \( (p = 0.01) \). In which the sectional matrix system resulted in an increase of contact tightness, where the use of the circumferential matrix system led to a decrease of contact tightness.

Regarding the three-surface cavities restored with the sectional matrix system a weak increase of contact tightness was found at the mesial \( (0.98 \pm 1.07 \text{ N}) \) and distal site \( (0.40 \pm 0.70 \text{ N}) \), whereas a slight decrease was found for the circumferential system. No statistically significant differences were found between the mesial and distal site, nor was there an effect of the used matrix system. No statistically significant influence of cavity design (mesially/distally) was recorded for all cavities (MO, DO and MOD) (Table 1).

At the contralateral control side also no statistically significant differences in proximal contact tightness were found between the measurements of before and after the treatment \( (p > 0.05) \).

### 4. Discussion

In the present study the influence of a restorative therapy on proximal contact tightness was investigated. Previous studies observed statistically significant differences in contact tightness when using different matrix systems.8,9,12 In a clinical study on two-surface cavities it was found that sectional matrices combined with separation rings resulted in an increase of mean contact tightness and that the use of a circumferential matrix resulted in a decrease of contact tightness compared to the situation before treatment. However the question arises which affect the different systems show when restoring three-surface cavities, therefore the study was performed on Class II (MO/DO) and Class II (MOD) restorations.

Regarding the two-surface cavities the results are in accordance with previous mentioned studies. In the present study, it could additionally be seen that there is no difference in proximal contact tightness between the mesially or distally located restorations.

The three-surface cavities show a less increase of contact tightness when restoring with separation ring compared to the two surface cavities. This could be explained by the fact that the two rings and matrices placed simultaneously both mesially and distally result in a separation effect in opposite direction and therefore diminish their effect at the applied contact area. Nevertheless, the use of these rings achieved an increase of contact tightness at the treatment site. To avoid this effect two different placement techniques could be proposed. First alternative consists of placing matrix and ring

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**Table 1 – Differences in proximal contact tightness \( \Delta T_1 - T_0 \) and standard error of the mean.**

<table>
<thead>
<tr>
<th>Cavity design</th>
<th>Measured contact area</th>
<th>Separation obtained by</th>
<th>( \Delta T_1 - T_0 ) [N]</th>
<th>Std Err Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>MO</td>
<td>Mesial</td>
<td>Separation ring (Palodent)</td>
<td>2.51</td>
<td>0.81</td>
</tr>
<tr>
<td>MO</td>
<td>Mesial</td>
<td>Wedge and Tofflemire retainer</td>
<td>-1.08</td>
<td>1.04</td>
</tr>
<tr>
<td>DO</td>
<td>Distal</td>
<td>Separation ring (Palodent)</td>
<td>2.82</td>
<td>1.14</td>
</tr>
<tr>
<td>DO</td>
<td>Distal</td>
<td>Wedge and Tofflemire retainer</td>
<td>-0.22</td>
<td>0.87</td>
</tr>
<tr>
<td>MOD</td>
<td>Mesial</td>
<td>Separation ring (Palodent)</td>
<td>0.98</td>
<td>1.07</td>
</tr>
<tr>
<td>MOD</td>
<td>Distal</td>
<td>Separation ring (Palodent)</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>MOD</td>
<td>Mesial</td>
<td>Wedge and Tofflemire retainer</td>
<td>-0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>MOD</td>
<td>Distal</td>
<td>Wedge and Tofflemire retainer</td>
<td>-0.78</td>
<td>1.14</td>
</tr>
</tbody>
</table>
only at one location of the cavity (e.g. mesially), restoring this part, removing matrix and ring and afterwards placing matrix and ring at the other contact with following restoration of this contact. The positive aspect of this technique consists of the unhindered separation effect of each ring and a good access to the cavity. But when using one ring and matrix after each other a contamination of the cavity with blood and saliva could occur when removing the first ring and applying the second one. A second alternative could be to apply matrix and ring at one location and also the matrix at the other contact area, then to restore the first contact area, remove the first ring and afterward to apply the second ring. With this technique the achievable separation of each ring is also not diminished by the other ring. But it is not secured when removing the first ring and applying the second one a contamination of the cavity happens. As there are no clinical studies yet available the two described alternative application techniques should not be recommended for clinical use at present time.

The circumferential matrix system showed similar results in two- and three-surface cavities. A possible reason could be the fact that the same application technique is used on two- and three-surface cavities. A possible variable influencing contact tightness is the thickness and shape of the matrix system. At two-surface cavities the circumferential matrix band has to pass through the not open contact site of the tooth. This will result in tooth displacement and therefore might hamper obtaining a tight contact at treatment site.

The used circumferential matrix system consisted of a pre-contoured matrix. An in vitro study by Loomans et al. showed no statistically significant difference in proximal contact tightness between pre-contoured and flat circumferential matrices. In the present study, the matrices were fixed by wedges and no extra pressure of a hand-instrument during polymerization of the first layer of composite was applied. Using an incremental technique with additional separation force by a hand-instrument provided only small statistically significant tighter proximal contacts compared to a bulk-fill technique without additional pressure as proved in previous studies. However, a negative effect when applying a hand instrument is a much increased marginal overhang. Therefore, in the present study the circumferential matrix system was used without a hand-instrument and was only combined with the pressure of interdental wedges.

According to this study a large intra- and inter-individual variation in proximal contact tightness exists, therefore it is difficult to give a definition of the ‘optimal’ adequate proximal contact tightness. The patients participating the study did not report any discomfort when a tight contact was reconstructed, whereas a loose or absent contact can cause food impaction, tooth migration and periodontal complications. As tighter contacts tend to loosen after a six month period and weaker contacts remain almost unchanged it can be proposed that achieving a slightly tighter contact is to prefer. The sectional matrix system used in this study achieved this result for two-surface MO, DO cavities and for the three-surface MOD cavities, whereas the circumferential matrix system, in which no additional separation techniques were used, failed to produce tight contacts in both cases (two- and three-surface cavities).

5. Conclusions

- Use of the sectional matrix system in two-surface Class II cavities resulted in statistically significantly tighter proximal contacts than the use of the circumferential matrix system.
- For the three-surface no statistically significant differences in contact tightness were found between the different matrix systems.
- Location of the cavity (mesially or distally) did not show to have any statistically significant effect on the obtained proximal contact tightness.

Conflicts of interest

The authors declare that no interest conflicts arise from the scientific work contained in this paper.

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