The long-term effect of a composite resin restoration on proximal contact tightness


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1. Introduction

A good proximal contact is important for a well functioning dentition. When a proximal contact is too loose this may lead to food impaction, tooth migration, periodontal complications and carious lesions.1–3 When the contact is too tight this may result in tooth migration or trauma of the periodontal tissues when excessive force has to be used to pass dental floss through the proximal contact.4,5 Clinically, a large variation in proximal contact tightness exists in individuals as well as between individuals.6 Moreover, the reconstruction of the proximal area always results in a change in the proximal contact.6 Clinical data on the long-term behaviour of restored proximal contacts is limited to one study, where dental floss was used to evaluate proximal contact tightness and no alterations in tightness were found in an 18-months period.7 Apparently, it is difficult to quantify an adequate and optimal proximal contact tightness.

Apart from the placement of a restoration or extractions another factor has been described that may influence proximal contact tightness. Mesial drift of teeth as a result of the so called anterior component of force might lead to a recovery of contact tightness at sites where the proximal contact is lost during a restorative procedure.8 Mesial drift is assumed to occur as a result of progressive tooth eruption (e.g. third molars) or by re-directed pressure due to mastication in mesially inclined teeth.9,10 The general opinion still is that a stable intercuspal relation impedes the mesial drift of teeth significantly.10,11

Proximal contact tightness can be measured according to the United States Public Health System criteria (USPHS) in which dental floss is used to evaluate contact tightness by recording the ease of dental floss passing interdentally.12 Another method to determine contact tightness is to use standardized metal blades or strips of shim stock of various thicknesses. The thickness at which the interdental proximal contact is lost is considered as the measure for the contact tightness. A change in contact tightness after restorative treatment will not always remain stable over time.

Objective: The aim of this study was to investigate changes in proximal contact tightness up to 6 months after the restorative treatment.

Materials and methods: In a randomised clinical trial Class II composite resin restorations were placed in 52 patients. Proximal contact tightness was measured before, directly after, and 6 months after treatment. These data were analysed statistically using linear regression and t-tests.

Results: Proximal contacts, that increased in tightness as result of the treatment tend to lose tightness after a 6-months period but remain tighter than before treatment. Proximal contacts, that decreased after treatment hardly change after 6 months.

Conclusions: A change in contact tightness after restorative treatment will not always remain stable over time.

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area initially prevented passage was recorded. A more accurate method to quantify the proximal contact tightness is to insert a thin metal strip interdentally and to pull it out in a horizontal direction with a tension recorder. The frictional force that resists withdrawal is related to the tightness of the proximal contact. Dörfer et al. constructed a device which was based on the removal of a metal strip in a vertical direction. A modified, more sophisticated version of this instrument – Tooth Pressure Meter – was used in a clinical trial to investigate tightness of proximal contacts of Class II composite resin restorations and enables an accurate quantitative measurement of differences in proximal contact tightness due to a restorative procedure. The aim of this study was to investigate changes in proximal contact tightness up to 6 months after the restorative treatment.

2. Materials and methods

In total 52 patients (17 males/35 females, 21–66 years) who participated in a randomised clinical trial on the reconstruction of Class II composite resin restorations were included in this study. In that study informed consent was obtained and all patients fulfilled the following inclusion criteria: good general health, minimum age of 18 years and fully erupted occluding teeth. Exclusion criteria were diastema between posterior teeth, presence of fixed partial dentures, severe periodontal diseases and tooth mobility more than mobility-score 1. After finishing the preparation, in which the proximal contacts with the adjacent teeth were totally cleared, teeth were randomly assigned to one of three experimental matrix systems (Tofflemire retainer (Produits Dentaire), Palodent Matrix System (Dentsply Caulk) or Contact Matrix System (Danville Materials)). Cavities were restored using a three-step adhesive system (Clearfil SA Primer, Clearfil Photo Bond) or a two-step self-etching system (Clearfil SE Bond) and a highly filled hybrid composite (Clearfil AP-X (A3), Kuraray Co., Osaka, Japan). Differences in proximal contact tightness before (T0) and directly after treatment (T1) were compared. In order to compare contact tightness directly after and 6 months after restorative treatment (T2), patients (n = 52) were now allocated to two groups based on the changes of proximal contact tightness directly after treatment (∆T1–0 = T1 – T0) (Table 1):

- Group A: ∆T1–0 > 0: patients for whom a tighter proximal contact was found directly after treatment (n = 28, mean increase 2.60 ± 0.45 N).

- Group B: ∆T1–0 ≤ 0: patients with an equal or looser proximal contact directly after treatment (n = 24, mean decrease 2.85 ± 0.60 N).

Informed consent was obtained and the study design was approved by the Central Committee on Research Involving Human Subjects of the Radboud University, Nijmegen in The Netherlands (CMO-nr: 2001/056). Included in the study were those patients from the clinical trial that had no other dental restoration placed during the research period of 6 months. After 6 months patients visited the practice and were examined by the same independent observer that did the pre- and post-operative recordings of contact tightness. First patients were interviewed whether the restored contact site provided inconvenience to them regarding interdental food impaction and/or the occurrence of post-operative sensitivity. Subsequently, proximal contact tightness was measured (T2) using the Tooth Pressure Meter, constructed at the University of Technology Delft in The Netherlands. This device uses a 0.05 mm thick metal strip inserted interdentally from the occlusal direction. The tightness of the contact is quantified as the maximum frictional force [N] needed to remove the strip slowly in occlusal (vertical) direction (Fig. 1).

Custom-written software in Excel (MS Office 2000, Windows) was used for data acquisition. At each contact site three measurements were taken of which the mean

![Image](https://example.com/figure1.png)
value was determined as the final result. A measurement was considered as failed when the outcome exceeded the maximum (pre-set) range between the three measurements of 0.5 N. In those cases a measurement was redone. The metal strip is replaced after each measurement session or sooner when deformations of the strip were visible, which may hamper the measurements. Six contact sites per subject were measured: the treatment site (CT) as well as the proximal contact sites mesially (CM) and distally (CD) of the treatment site (Fig. 2) and the proximal contacts at the same locations in the contra-lateral quadrant, serving as controls.

Differences in proximal contact tightness before and after treatment were calculated ($\Delta T_{1,0} = T_1 - T_0$) as well as differences in contact tightness after treatment and 6 months ($\Delta T_{2,1}$). To establish the relations between $\Delta T_{1,0}$ and $\Delta T_{2,1}$ a linear regression analysis was applied. To compare the mean differences of contact tightness a Student’s $t$-test was used ($p < 0.05$).

### 3. Results

None of the 52 subjects reported contact sites inconveniences after 6 months. After 6 months, for group A, consisting of patients with an increase of contact tightness due to treatment, a statistical significant mean decrease ($\Delta T_{2,1} = -1.37 \pm 0.36$ N) was found ($p = 0.001$) (Table 1). To determine the relation between the obtained increase in contact tightness directly after treatment ($\Delta T_{1,0}$) and the observed decrease in contact tightness after 6 months ($\Delta T_{2,1}$), the slope of the regression line between these variables was calculated as $-0.57$ (95% CI $[-0.78; -0.36]$) and was found to be statistical significantly different from ‘0’ ($p < 0.001$). The full regression equation for this group is given by: $\Delta T_{2,1} = 0.11 + (-0.57 \times \Delta T_{1,0})$. These results imply that the larger the increase of contact tightness directly after treatment, the larger the decrease of contact tightness after 6 months. However, the mean decrease of contact tightness after 6 months was always less than the mean increase of contact tightness directly after treatment as can be seen on the right side of the Y-axis in Fig. 3.

After 6 months, for group B, consisting of patients with a decrease of contact tightness due to treatment, a statistical significant mean increase ($\Delta T_{2,1} = 0.73 \pm 0.30$ N) was found ($p = 0.001$) (Table 1). To determine the relation between the decrease in contact tightness directly after treatment ($\Delta T_{1,0}$) and increase in contact tightness during the 6 months period ($\Delta T_{2,1}$), the slope of the regression line was calculated as 0.001 (95% CI $[0.21; 0.22]$), which was not statistical significantly different from ‘0’ ($p = 0.991$). The full regression equation for this group is given by: $\Delta T_{2,1} = 0.73 + (0.001 \times \Delta T_{1,0})$. This implies that this small increase of contact tightness recorded after 6 months was not related to the amount of decrease of contact tightness obtained directly after treatment as can be seen on the left side of the Y-axis in Fig. 3.

Regarding the measuring sites mesially (CM) and distally (CD) of the treatment site it can be seen from Table 1 that if an increased contact tightness was obtained at the treatment site (group A) directly after treatment, a statistically significant

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**Fig. 2** – Location of the measuring sites (CM, CT and CD) in case when restoring a DO-preparation in tooth 14.

**Fig. 3** – Relation between differences in proximal contact tightness after 6 months ($\Delta T_{2,1}$) with differences directly after treatment ($\Delta T_{1,0}$) together with two regression lines at left and at right side of the Y-axis. Dashed diagonal line indicates when a changed proximal contact tightness returned to its original value.
increase of contact tightness at the mesial site of 0.82 ± 0.26 N as well as at the distal site of 0.35 ± 0.15 N were found (respectively, p = 0.004 and p = 0.027). After 6 months a decrease in tightness was recorded at the mesial contact of −0.81 ± 0.25 N and at the distal contact of −0.41 ± 0.22 N, resulting in a proximal contact tightness that was not statistically significant different after 6 months compared to the situation before treatment (mesial contact: p = 0.954; distal contact: p = 0.678). The teeth in group B show a non significant decrease of contact tightness at both the mesial and distal site directly after treatment and showed a further decrease of contact tightness at the mesial (−0.53 ± 0.26 N) and at the distal site (−0.38 ± 0.13 N) after 6 months. This resulted in statistically significant looser contacts at the mesial (−0.76 ± 0.19 N) and distal contact (−0.66 ± 0.20 N) after 6 months as compared to the situation before treatment (respectively, p = 0.001 and p = 0.003).

At the contra-lateral control sites no statistically significant differences in proximal contact tightness were found between the situation before treatment and after 6 months (for all comparisons: p > 0.05).

4. Discussion

In the present study the influence of a restorative intervention on the proximal contact was investigated after a period of 6 months. The regularly dental check-ups are normally carried out after a period of 6 months. As new dental treatments could influence the proximal contact tightness of interest, the proximal contact tightness was re-measured during this visit. Moreover, it can be assumed that the most relevant changes of contact tightness will occur in the period directly following placement of the restoration.

The proximal contacts at the contra-lateral control side showed no significant differences in tightness after 6 months, therefore it is likely that the observed differences in contact tightness at the treatment side are due to the restorative intervention. From this study it can be concluded that proximal contact tightness is subject to change after restorative treatment. In another clinical study, where dental floss was used to record changes of proximal contact tightness no differences were found in tightness after 18 months.7 The different outcome of the present study is most likely due to the more accurate method of recording proximal contact tightness.6

In the present study patients were allocated to two groups, those with proximal contacts that became tighter and those that became looser after treatment. It is shown that both groups react differently after 6 months. Tighter contacts after treatment tend to loosen, although they remain significantly tighter than the situation before treatment, whereas looser contacts after treatment increase slightly in contact tightness over time. The effect which occurred in the group with the tighter contacts might be explained by an ‘adaptation mechanism’ of the periodontal tissues and/or proximal wear of either the restorative material or the adjacent tooth surface. The ‘adaptation mechanism’ is based on the orthodontic principle of tooth movement in which extra tightness applied at the treatment site is spread through the proximal contacts in mesial and distal direction over more contact areas resulting in a new balanced situation. As also the contact tightness at the contacts mesially and distally decreased over the 6-months period after an increase directly after treatment, it is likely that more teeth in the quadrant are involved in this process. Another explanation of this effect might be the proximal wear, as it was found that after 6 months the mean proximal wear of a highly filled composite was ±50 μm, whereas the enamel lost ±5 μm.19 They also found no differences neither between premolars and molars nor between the restorative materials. Moreover, the proximal wear appeared to decrease over time. In the present study the amount of proximal wear could not be recorded, but might have played a role. The same composite resin was used for all restorations and therefore not a variable of study in the amount of proximal wear. However, restorations with a tighter proximal contact after treatment may be more prone to proximal wear than when the contact is loose, which might result in a decrease of proximal contact tightness. For restorations with a looser proximal contact it is likely that proximal wear has played a minor role in the result, compared to those with tighter contact. If the proximal contact at the treatment site became looser, no statistically significant effect at both mesial and distal site was recorded directly after treatment. Only after 6 months a statistically significant decrease was found at both sites, possibly due to a ‘collapse’ of tooth into the weaker proximal contact area at the treatment site.

Based on the phenomenon of the anterior component of force proximal contacts that became looser directly after treatment should become tighter.10,16 The results of this study show that this did not happen. However, the relatively short period of evaluation and the fact that occlusal forces where not investigated make it not impossible that the phenomenon exist.

The intra- and inter-individual variation in contact tightness is very large and therefore an optimal value for contact tightness cannot be given.6 According to this study no inconveniences were reported when the proximal contact tightness was changed. From other clinical studies it is known that absent or too loose proximal contacts can lead to food impaction, tooth migration, periodontal complications and carious lesions20,21 although many people function clinically well without having a tight proximal contact. On the contrary, too tight proximal contacts may hamper passing dental floss through the contact area, causing inconveniences and periodontal problems.1,4,5

5. Conclusions

Based on the results of this study it can be concluded that:

- Proximal contacts of a posterior composite resin restoration, which are stronger than before treatment tends to diminish after a 6-months period.
- Proximal contacts, which are weaker than before treatment remains almost unchanged after a 6-months period.