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Clinical Research

A Clinical Study on Interdental Separation Techniques

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Clinical Relevance

When separation is required for restorative procedures, special separation rings may be more useful than wooden wedges.

SUMMARY

The effect of interdental separation of a special separation ring and wooden wedge was investigated. In a split-mouth design, 27 patients were randomly assigned to one of two groups (W or S). In 11 patients, an interdental wooden wedge (Hawe-Neos) was placed (group W), and in 16 patients, a separation ring (Composi-Tight Gold) was placed at the contact between teeth 4/5 and 5/6. Simultaneously, in both groups, a wooden wedge, combined with a separation ring (Composi-Tight Gold), was placed on the contact between teeth 4/5 and 5/6 (reference group W+S). To measure proximal contact tightness, frictional forces were recorded at the removal of a 0.05 mm thick metal matrix band inserted between adjacent teeth. Contact tightness was measured at contacts 4 and 5 and at 5 and 6 in the third and fourth quadrant using the Tooth Pressure Meter prior to applying separation devices (T_0) five minutes after application (T_1) and five minutes after removal of the devices (T_2).

The effect of separation was determined by calculating the differences between contact tightness before application and contact tightness with the devices *in situ* (T_1-T_0). Interdental recovery was calculated by the difference in contact tightness before application and after removal of the devices (T_2-T_0). To assess the presence of statistically significant differences between these measurement times, paired *t*-tests were applied. With each patient, either a comparison between

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W and W+S or S and W+S was made. For both W versus W+S and S versus W+S, paired *t*-tests were applied to compare differences (T_1-T_0 and T_2-T_0) between the separation devices. Within a patient, groups W and S could not be compared, therefore, to compare separation achieved between these two devices, unpaired *t*-tests were used.

The increase in contact tightness measured at contact 4 and 5 for group W (0.98±0.26 N) was statistically significantly less compared to the increase in group S (5.48±0.88 N) ($p<0.001$) or group W+S (4.62±0.68 N) ($p=0.02$). No significant differences were found between groups S and W+S ($p=0.77$). For all groups, five minutes after removal of the devices, the contact tightness at contact 4 and 5 and at contact 5 and 6 were still significantly weaker compared to the tightness at baseline ($p<0.02$). When separation is required for restorative procedures, such as at placement of a Class II resin composite restoration, special separation rings may be more useful than wooden wedges.

INTRODUCTION

In order to obtain tight proximal contacts when placing Class II resin composite restorations, interdental separation can displace adjacent teeth, resulting in a larger mesial-distal space of the interdental area. This displacement is required to compensate for the thickness of the matrix and polymerization shrinkage of the resin composite. One of the first techniques recommended to achieve tight proximal contacts is the "pre-wedging" or "multiple wedging" technique.[1-3] This technique is based on separation using wooden wedges placed interdentally. Before cavity preparation, a wooden wedge is pressed firmly into the interdental area and is kept in place during preparation and the restorative procedure. In order to facilitate reconstruction of the proximal contact tightness, special separation rings can be used.[4-7] This separation ring is placed after the insertion of a matrix and is kept in place during the restorative procedure. Due to constant pressure on the proximal contact area, interdental separation is achieved. In an *in vitro* study, these rings have been shown to result in tight proximal contacts.[4,6-7] Also, in a clinical study, it was found that use of separation rings during a procedure to reconstruct Class II resin composite restorations resulted in an increase in contact tightness;[5] whereas, in that same study, the pre-wedging technique resulted in a decrease in contact tightness. However, it is not clear whether this result is also due to the use of different matrix systems. No clinical research is available that compares the effectiveness of both techniques in obtaining interdental separation.

Recently, a new device has been developed that has been shown to produce reliable, reproducible clinical results in measuring proximal contact tightness.[5,8-9] With this device, it is possible to record minor changes in proximal contact tightness. This study clinically investigated the effect of separation of a special separation ring and a wooden wedge.

METHODS AND MATERIALS

Among students at the dental school of the University of Heidelberg, Germany, 27 volunteers (11 male/16 female, between the ages of 19 and 25) were selected. Informed consent was obtained, and the study was approved by the Central Committee on Research Involving Human Subjects (CMO-nr: 2001/056). Inclusion criteria were good general health, the presence of a complete sound dentition with 28 teeth (third molars not visually present) and no posterior diastema. Each patient was randomly assigned to one of two groups (W or S), where two independent observers (CD and BL) performed the measurements. A split-mouth design was used to compare the separation effect of either a wooden wedge or a separation ring in the fourth quadrant to a wedge combined with a separation ring in the third quadrant (reference group) (Table 1).

Proximal contact tightness was measured using the Tooth Pressure Meter.[5] Using the meter, the tightness of the contact is quantified as the maximum frictional force [N] needed to slowly remove a 0.05 mm thick metal strip in the occlusal direction (vertical) (Figure 1). At each contact site, three measurements were taken, of which the mean value was determined as the final result. Due to deformations of the metal (burrs on the strip) or a non-parallel removal of the strip from the interdental area, this could result in relatively overly tight proximal contact measurements. Therefore, measurements were considered to "fail" when the outcome exceeded the maximum (pre-set) range among the three measurements of 0.5 N. In that case, a measurement was redone.

Table 1: *Measurement Sessions (T_0, T_1 and T_2) of the Three Groups (W, S and W+S) Used in the Study*

	Separation Obtained by	T_0	T_1	T_2
Experimental Groups				
Group W	Wedge	Contact 4-5	Contact 4-5	Contact 4-5
		Contact 5-6	---	Contact 5-6
Group S	Separation ring	Contact 4-5	Contact 4-5	Contact 4-5
		Contact 5-6	---	Contact 5-6
Reference Group				
Group W+S	Wedge + ring	Contact 4-5	Contact 4-5	Contact 4-5
		Contact 5-6	---	Contact 5-6

At baseline (T_0), proximal contact tightness was measured between the first and second premolar (contact 4 and 5) and between the second premolar and the first molar (contact 5 and 6). Then, the separation devices were applied according to the protocols:

- Group W (n=11): An interdental wooden wedge (Hawe-Neos, Bioggio, Switzerland) was placed interdentally between the second premolar and the first molar in the fourth quadrant (contact 5 and 6). This wedge was pushed firmly into the proximal area from the buccal side.
- Group S (n=16): A separation ring (Composi-Tight Gold AU400, Garrison Dental Solutions, Spring Lake, MI, USA) was placed on the contact between the second premolar and the first molar in the fourth quadrant (contact 5 and 6).
- Reference group W+S (n=27): An interdental wooden wedge was combined with a separation ring and placed between the second premolar and the first molar in the third quadrant.

As the separation devices were placed on the contact between the second premolar and the first molar (contact 5 and 6), the transferred effect of separation was measured at the mesial contact between the first and second premolar (contact 4 and 5).

The separation devices were left *in situ* for five minutes, then the proximal contact tightness was re-measured (T_1) between the first and second premolar in the third and fourth quadrants. Next, the separation devices were removed and, after five minutes of recovery time, all contacts between the first and second premolar (contact 4-5) and between the second premolar and first molar (contact 5-6) in both quadrants were re-measured (T_2).

The effect of separation was determined by calculating differences between contact tightness before application and contact tightness with the devices *in situ* (T_1-T_0). Interdental recovery was calculated by the difference in contact tightness before application and after removal of the devices (T_2-T_0). To assess the presence of statistically significant differences between these measurement times, paired *t*-tests were applied. Within each patient, either a comparison between W and W+S or S and W+S were made. Both for W versus W+S and S versus W+S, paired *t*-tests were applied to compare the differences (T_1-T_0) and (T_2-T_0) between the separation devices. Groups W and S cannot be compared within a patient; therefore, to compare separation achieved between these two devices, unpaired *t*-tests were used.

RESULTS

In Table 2, the mean proximal contact tightness for all contact areas is shown at baseline (T_0), after five minutes with separation devices *in situ* (T_1) and five minutes after removal of the devices (T_2). Placement of all separation devices resulted in a statistically significant increase of contact tightness (T_1-T_0) at contact 4 and 5 (p<0.01). Insertion of a wedge resulted in an increase of 0.98±0.26 N. From Table 3, it can be seen that wedge separation was statistically significantly less compared to that obtained by a separation ring (5.48±0.88 N) (p<0.001) or by a wedge combined with a separation ring (4.62±0.68 N) (p=0.02). No statistically significant difference was found between the separation ring or wedge combined with a separation ring (p=0.77).

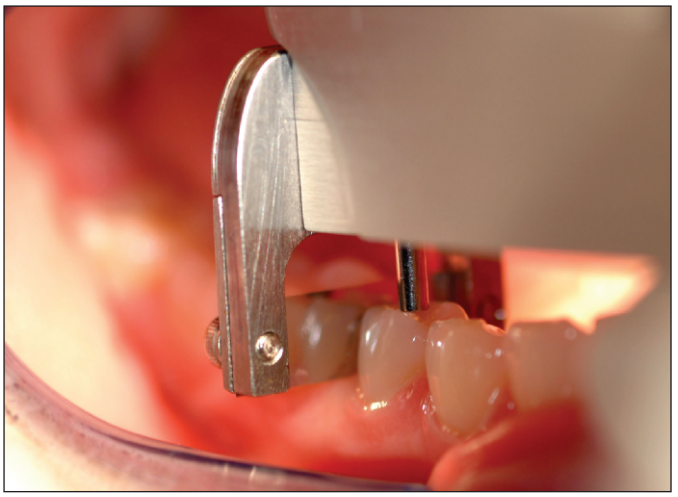

Figure 1. *Clinical procedure of measuring proximal contact tightness using the Tooth Pressure Meter.*

Table 2: *Recorded proximal contact tightness and standard error of the mean (SEM) for all three groups at both contact sites (4-5 and 5-6), together with the differences in interdental separation found between the measurement sessions (paired t-test)*

	n	T_0 (SEM) [N]	T_1 (SEM) [N]	T_2 (SEM) [N]	T_1-T_0 (SEM) [N]	p	T_2-T_0 (SEM) [N]	p
Contact between teeth 4-5								
Wedge	11	2.69 (0.26)	3.67 (0.28)	2.10 (0.19)	0.98 (0.26)	0.006	-0.59 (0.20)	0.016
Ring	16	3.51 (0.34)	8.99 (0.86)	2.58 (0.27)	5.48 (0.88)	<0.001	-0.93 (0.20)	<0.001
Wedge + ring	27	3.28 (0.40)	7.90 (0.74)	2.53 (0.32)	4.62 (0.68)	<0.001	-0.75 (0.22)	0.002
Contact between teeth 5-6								
Wedge	11	3.57 (0.44)	---	3.05 (0.38)	---	---	-0.52 (0.16)	0.009
Ring	16	4.24 (0.51)	---	2.87 (0.40)	---	---	-1.37 (0.20)	<0.001
Wedge + ring	27	5.03 (0.78)	---	4.00 (0.78)	---	---	-1.03 (0.34)	0.006

Table 3: *Differences in interdental separation between the techniques for both locations (4-5 and 5-6) (unpaired* t*-test for the comparison of groups W and S; paired* t*-test for the comparisons of groups W and W+S and groups S and W+S)*

	T_1-T_0			T_2-T_0		
	ΔT_1-T_0 (SEM) [N]	p	95% CI	T_2-T_0 (SEM) [N]	p	95% CI
Contact between teeth 4-5						
Wedge versus ring	-4.50 (0.92)	<0.001	[-6.44 … -2.56]	0.33 (0.29)	0.26	[-0.27 … 0.93]
Wedge versus wedge + ring	-2.85 (1.00)	0.02	[-5.07 … -0.63]	-0.39 (0.42)	0.38	[-1.33 … 0.56]
Ring versus wedge + ring	0.31 (1.04)	0.77	[-1.90 … 2.52]	0.20 (0.25)	0.43	[-0.34 … 0.75]
Contact between teeth 5-6						
Wedge versus ring	---	---	---	0.85 (0.27)	<0.01	[0.29 … 1.41]
Wedge versus wedge + ring	---	---	---	-0.03 (0.62)	0.96	[-1.42 … 1.36]
Ring versus wedge + ring	---	---	---	0.02 (0.32)	0.94	[-0.66 … 0.71]

Five minutes after removal of the devices for all three groups, a statistically significant weaker proximal contact tightness was recorded at contact 4 and 5 compared to the contact tightness at baseline (T_2-T_0) ($p<0.016$). No statistically significant differences in decrease were found among these three groups (for all comparisons: $p>0.26$).

At contact 5 and 6, statistically significant weaker contacts were also found in all groups compared to contact tightness at baseline (T_2-T_0) ($p<0.01$). No statistically significant decreased differences were found either between the wedge and the wedge combined with the ring ($p=0.96$) or between the ring versus wedge combined with ring ($p=0.94$). However, a statistically significant decreased difference was found between wedge and ring ($p<0.01$).

DISCUSSION

In this study, two separation techniques, similar to those used in restorative dentistry, were clinically evaluated; it was found that the traditional "pre-wedging" technique,[2,8] where a wedge is pushed firmly into the proximal area, resulted in relatively little interdental separation when compared to the use of a separation ring or the combination of a separation ring with wedge. This might be explained by continuous pressure produced by the tines of the rings on the interdental contact; whereas, a (wooden or plastic) wedge is only pressed once into the interdental area. Moreover, a wooden wedge absorbs fluids, such as saliva and blood, resulting in a weaker, more flexible wedge that adapts itself to the natural anatomic tooth contour, resulting in even less interdental separation. Therefore, interdental separation obtained by wedges might be improved if they are pushed into the interdental area more frequently during placement.

Within this study design, it was not possible to measure the effect of separation directly on the contact on which the devices were *in situ*, as measurement of the contact tightness was hindered. A study by Loomans and others[5] showed that applied changes of contact tightness at an experimental contact site were transferred through the proximal contacts. For that reason, it was decided to measure mesial contact of the experimental site.

It has been shown that the additional effect of a wedge is negligible compared to the effect of a ring alone. Nevertheless, the wedge remains an essential tool in restoring Class II cavities, since, after placement of the matrix wedge, it helps to ensure good adaptation of the matrix against the tooth. Moreover, the use of a wedge *in situ* during preparation of the cavity can help the operator obtain a well-controlled, dry operation field.[2-3]

After removal of the separation devices, proximal contact tightness can be seen at contact 4 and 5, and contact 5 and 6 is weaker than before the intervention. At both sites, this can be explained by an ongoing recovery of the periodontal ligament. In a pilot-study by Hellie and others,[10] it was found that the recovery capacity of the contact tightness after the insertion of a wedge was approximately 90% in the first 30 seconds and the remaining 10% required an additional two to three minutes. However, from this study, it can be concluded that total recovery needs more time, but how long it takes for a complete recovery remains unknown.

CONCLUSIONS

When separation is required for restorative procedures, such as placement of a Class II resin composite restoration, special separation rings may be more useful than wooden wedges.

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