Short communication

Randomized clinical trial on single retainer all-ceramic resin-bonded fixed partial dentures: Influence of the bonding system after up to 55 months

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ABSTRACT

Objectives: This study evaluated the clinical outcome of all-ceramic resin-bonded fixed partial dentures (RBFPDs) with a cantilevered single-retainer design.

Methods: Thirty anterior zirconia ceramic RBFPDs were inserted using either a phosphate monomer containing resin (Panavia 21 TC; N = 16) or an adhesive bonding system with a phosphoric acid acrylate primer (Multilink–Automix with Metal/Zirconia primer; N = 14).

Results: During a mean observation time of 41.7 months one debonding occurred in each group. Both RBFPDs could be rebonded successfully resulting in a three-year survival rate of 100%.

Conclusion: Independent of the bonding system cantilevered zirconia ceramic RBFPDs showed promising results during the first three years.

Clinical significance: Single-retainer zirconia ceramic RBFPD present an alternative treatment option offering good aesthetics, a minimal invasive preparation, a high biocompatibility and can even be used to treat juvenile patients who do not yet come into consideration for implant placement. No significant influence of the bonding system used was detected so far.

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1. Introduction

Due to increased aesthetic demands and the high biocompatibility all-ceramic restorations become more important in modern dentistry. Densely sintered zirconia ceramic is the strongest all-ceramic framework material available today and provides high fracture strength and fracture toughness1 and therefore might be suitable for the fabrication of cantilevered all-ceramic resin-bonded fixed partial dentures (RBFPDs).2,3 In adhesive dentistry a stable and reliable bond to the resturation is essential. Traditional adhesive techniques used with silica-based ceramics do not work effectively with zirconia4 therefore different bonding methods and luting materials to zirconia ceramic have been described in the literature but not all of these showed an adequate bond strength especially after artificial ageing.5,6 Several technologies are being utilized clinically today7 but there is very limited data on the clinical durability of the adhesive bond to zirconia ceramic and the survival of such adhesive restorations. Recent data on single retainer all-ceramic RBFPDs made
from glass-infiltrated alumina ceramic showed a ten-year survival rate of 94%. However no data on the clinical outcome of zirconia ceramic RBFPDs is available to date.

In recent laboratory studies a resin cement with a special primer for zirconia ceramic (Multilink-Automix with Metal/Zirconia-Primer, Ivoclar Vivadent) achieved a satisfying but statistically significantly lower bond strength to air-abraded zirconia ceramic than a phosphate monomer containing luting resin (Panavia, Kuraray). However, it is not known whether this laboratory difference has any clinical relevance.

The null hypothesis of this study was that the survival rate of zirconia ceramic RBFPDs is not influenced by the bonding system.

2. Materials and methods

This study was approved by the ethics committee of the University at Kiel and each patient gave written informed consent before entering the study. The sample size was determined by the objective to prove a clinically comparable stable bond strength of Multilink compared to Panavia 21 which showed good clinical long-term results. It was not the intention to verify slight differences in bond strength. In case of a missing durability in bond strength large differences in survival would be expected since clinically inadequate bond strength will cause debonding of the RBFPDs. Therefore the expected difference in debonding rate (effect size) was set to a rather high value of δ = 40%. The estimated control group event rate was 6% and with a total of 30 restorations there is a 70% chance of detecting a significant difference at a two sided .05 significance level. Between October 2006 and November 2007, 27 patients in need of prosthodontic restoration in the anterior region were screened and rated to be eligible. The following inclusion criteria had to be met by the patient or the tooth to be eligible: (1) patients had to be at least 14 years of age, (2) patients must not show clinical symptoms of bruxism, (3) patients must not participate in collision, full or semi-contact sports (4) no or no untreated advanced periodontitis, (5) oral hygiene had to be at least average, (6) one caries free or almost caries free abutment tooth had to be available, (7) sufficient space for the retainer wing available and (8) patients willingness to return at regular intervals for at least 5 years for evaluation. The maximum number of restorations per participant was restricted to two. All patients were enrolled, received treatment and were recalled by clinicians of the Department of Prosthodontics, School of Dentistry, Kiel, Germany. Each restoration received an identification number following the order of enrolment. Odd identification numbers were allocated to one study group and even numbers to the opposite group. If a patient received two restorations the second restoration was allocated to the opposite study group than the first restoration was allocated to. Identification numbers were assigned by the study’s supervisor and a random generator was used to allocate the two groups to the intended treatment plans. After randomizing, two patients in one of the groups had to be excluded from the study: one died before prosthodontic treatment and another patient’s pre-treatment turned out to be too extensive. Therefore twenty-five patients received prosthodontic treatment within the study. Five of them received two restorations. Overall, 30 anterior RBFPD with a cantilevered single-retainer design were made from zirconia ceramic (IPS e.max ZirCAD veneered with IPS e.max Ceram; both Ivoclar Vivadent). RBFPDs replaced either upper (63.3%, n = 19) or lower (36.7%, n = 11) incisors (Fig. 1). Descriptive statistics of measured baseline characteristics are tabulated as shown in Table 1.

The preparation of the abutment teeth provided a definite seat for the restoration but no mechanical retention (Fig. 2). Functioning of the restorations therefore relied completely on the resin bond.

After air-abrasion of the retainer wings (50 μm alumina particles at 0.25 MPa) and etching the enamel with 36% phosphoric acid for 30 s, the RBFPDs were inserted using either a phosphate monomer containing resin (Panavia 21 TC; N = 16) without any primer or using an adhesive bonding system with a phosphoric acid acrylate primer for the zirconia ceramic (Multilink-Automix bonding system with Metal/Zirconia primer; N = 14). Times until debonding, failure or censoring (i.e. last follow-up examination) as well as any minor complications were recorded.

Non-parametric tests and Life Tables analysis of SPSS Software (SPSS Inc., Chicago, USA) were used to determine differences between both study groups.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Panavia</th>
<th>Multilink</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients (n)</td>
<td>16</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>Male</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Mean age (y) (±SD)</td>
<td>36.6 (20.4)</td>
<td>29.6 (16.8)</td>
<td>33.3 (18.8)</td>
</tr>
<tr>
<td>Tooth replaced (FDI)</td>
<td>11</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>1</td>
<td>2</td>
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<td>12</td>
<td>1</td>
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</tr>
<tr>
<td></td>
<td>42</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
3. Results

Within the observation period of 41.7 months (min. 9.4, max. 55.9) two debondings and one minor complication occurred. One debonding occurred in each group (after 11.1 months with Panavia and after 20.8 months with Multilink). According to the patients reports both debondings were caused by traumatic impacts (hits/pushes on chin and/or teeth). Both RBFPDs were successfully rebonded. After manually removing resin leftovers off the enamel surface with hand instruments, the retainer wing and the enamel surface were treated in the exact same procedure as they were when first bonded and as mentioned above (air-abrasion of the retainer wing, etching the enamel, insertion of the RBFPDs using either a phosphate monomer containing resin (Panavia 21 TC) without any primer or using an adhesive bonding system with a phosphoric acid acrylate primer for the zirconia ceramic (Multilink-Automix bonding system with Metal/Zirconia primer).

In addition, the rotation of a central incisor abutment was detected during recall (Panavia group). The abutment was de-rotated using a thermoformed splint. Even though investigated in different studies\textsuperscript{12,13} no chipping of the veneer porcelain occurred in this trial.

If debonding was considered as (partial) technical failure the overall three-year survival rate calculated with SPSS Software according to Kaplan–Meier\textsuperscript{14} was 93.1% (Fig. 3) (Panavia 93.3%, N = 16; Multilink 92.9%, N = 14) without a statistically significant difference between groups (Gehan-Wilcoxon, \( p > 0.05 \)). If only the final loss of a RBFPD was considered as failure and therefore considering rebonded RBFPDs as success, the three-year survival rate increased to 100%.

4. Discussion

Both bonding systems used achieve their bond strength by bonding directly to the oxidic surface of the air-abraded and ultrasonically cleaned zirconia ceramic via a phosphate monomer (MDP) contained in the resin itself (Panavia 21) or via a phosphoric acid acrylate contained in the primer used (Multilink).

Despite significant differences in bond strength between the tested bonding systems in a recent laboratory study\textsuperscript{10} their clinical outcome with RBFPDs did not differ within the first three years. It remains to be seen whether RBFPD survival will be influenced during long-term observation.

Except for a minor rotation of a central incisor abutment no clinically relevant movement or tilting of abutment teeth was recorded in this study, which is in agreement with other studies on cantilevered RBFPDs\textsuperscript{2,15}

None of the reported complications resulted in the final loss of the RBFPD. Both debondings could be related to traumatic impacts and therefore were not related to the bonding system. After rebonding of the RBFPDs their function was not impaired in any way.

Independent of the bonding system single-retainer cantilevered zirconia ceramic RBFPDs showed promising results during the first three years. Even though the small number of RBFPDs involved in this study (\( n = 30 \)) might limit the findings, their clinical outcome is comparable to metal-ceramic cantilevered RBFPDs.\textsuperscript{16} However, it has to be kept in mind that the current results support the use of single-retainer all-ceramic RBFPDs only for the anterior region. However, for posterior tooth replacement using two abutments inlay-retained fixed dental prostheses made from zirconia ceramic might be an alternative treatment option.\textsuperscript{17,18}

5. Conclusion

Cantilevered all-ceramic RBFPDs made from zirconia ceramic present a promising treatment alternative for the replacement of missing incisors. After 3 years of clinical service a phosphate monomer modified resin cement as well as a modern resin cement with a special primer for zirconia ceramic showed successful clinical results.
Acknowledgment

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REFERENCES