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All-ceramic resin-bonded fixed dental prostheses: Treatment planning, clinical procedures, and outcome

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Single-retainer resin-bonded fixed dental prostheses (RBFDPs) present a minimally invasive treatment option as an alternative to implant-retained restorations in the esthetic zone. Advantages such as applicability to juvenile patients who do not come into consideration for implant therapy, and highly predictable and esthetic results make them a valuable treatment modality. This article outlines the treatment procedures with an all-ceramic RBFDP and reviews the existing data on the clinical outcome of this prosthetic therapy. The materials used for fabrication and insertion of the RBFDPs as well as the current scientific data are discussed. *(Quintessence Int 2014;45:291–297; doi: 10.3290/j.qi.a31328; Originally published in Quintessenz 2013;64(10):1225–1232)*

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In recent years implant therapy has gained importance when replacing missing single teeth adjacent to caries-free teeth. However, such therapy always includes the need for surgical intervention. In order to obtain esthetic results a second surgical intervention is often needed to optimize the soft tissue. Implant therapy is still the treatment of choice in many cases involving caries-free adjacent teeth. However, there are also many cases in which implant therapy either is not indicated, for example because of the patient's age or insufficient space between the adjacent teeth/roots, or is simply refused by the patient.

Single-retainer all-ceramic resin-bonded fixed dental prostheses (RBFDPs) present a viable, esthetic, and minimally invasive treatment alternative in such cases. In addition they offer further advantages such as applicability to juvenile patients, simplified tooth preparation, low costs, the preservation of alternative treatment options, no risk of pulp irritation, low risk of caries since no unnoticed loss of retention will occur, and no unphysiologic splinting of the adjacent teeth. Despite the scientific acceptance of anterior RBFDPs, they are not commonly used by general dental practitioners.[1]

BACKGROUND

The first articles on treatment with RBFDPs using metal frameworks were published in the mid-1970s.[2,3] In the early 1980s, metal-ceramic RBFDPs with an electrolytic etching of the metal surface[4] became widely known as Maryland FDPs.[5] Various types of RBFDPs are still commonly referred to as Maryland FDPs, although they often do not meet the originally described design characteristics.

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Fig 1 A single-retainer zirconia RBFDP prior to insertion.

Fig 2 Missing lateral incisor to be replaced.

A single-retainer design for RBFDPs was introduced in the beginning of the 1980s.[6] The introduction of this design arose from clinical experience, since FDPs with the classic two-retainer design sometimes had complications from debonding of one of the retainer wings. Some of these FDPs were converted to a single-retainer design by cutting off the debonded retainer wing,[7] and therefore remained fully functional. However, metal-ceramic RBFDPs still had an unfavorable effect on the translucency and the color of the abutment tooth. In addition, a retentive abutment preparation using proximal grooves was required to reduce the risk of debonding of the flexible metal-retainer wing.[1]

In the early 1990s, with the continuous development of dental ceramics, all-ceramic RBFDPs were introduced. To begin with, these were made out of a glass-infiltrated alumina ceramic.[8] Whilst in clinical service, these all-ceramic RBFDPs sometimes showed fractures within the proximal connector between one of the retainers and the pontic.[9] In these cases the same treatment as described for the metal-ceramic RBFDPs was carried out, and the two-retainer design was converted into a single-retainer design in order to keep the restorations in function. As a consequence of such fractures and the few complications of the severed restorations, a single-retainer all-ceramic RBFDP made from glass-infiltrated alumina ceramic was introduced in 1997.[10] Clinically, these single-retainer RBFDPs showed even higher survival rates than the classic two-retainer RBFDPs made from alumina ceramic.[11] With the advancement of zirconia ceramic into dentistry, an even stronger framework material with a considerably higher fracture strength became available for fabrication of all-ceramic RBFDPs. In the anterior region, single-retainer all-ceramic RBFDPs therefore present the state of the art in resin-bonded prosthodontics. A possible alternative might be the use of lithium disilicate ceramic as long as sufficiently strong connector sizes can be achieved.[12]

INDICATIONS

A single-retainer RBFDP (Fig 1) is indicated when a single anterior tooth is missing and a vital abutment tooth exists at least on one side (Fig 2). There must be sufficient space from the abutment tooth to the opposing arch (about 0.8 mm) for the retainer, and the abutment tooth should be mostly free of caries and fillings, as well as serious abrasions of the enamel. Sufficient enamel surface suitable for resin bonding must be available on the abutment tooth. If small dental fillings are present, they should be covered completely by the RBFDP framework.

CLINICAL PROCEDURE

In order to determine pretreatment needs and to evaluate the possible treatment result with an RBFDP, the correct indications should be evaluated by thorough clinical diagnosis and planning. Besides parameters like dental and periodontal status, the occlusal relationship

Fig 3 Removable wax-up during intraoral try-in.

should be checked, particularly when restoring the maxilla. In the anterior maxilla, a lack of space due to a large vertical overlap can usually be eliminated by a minimal protrusion of the abutment tooth and the neighboring teeth. Creation of the required space solely by enamel preparation is not recommended, since the final preparation has to be restricted to the enamel and must not extend into the dentin under any circumstances. To determine the available space during static and dynamic occlusion, diagnostic casts should be made on which a diagnostic preparation and wax-up can be created.

The dynamic occlusion in the region of the planned pontic has to be checked with regard to the intended incisal length. Composite build-ups to ensure canine guidance can be a viable option to avoid objectionable dynamic occlusal contacts on the pontic after insertion of the RBFDP. Composite build-ups might also be used to broaden a neighboring tooth in order to adjust the width of the edentulous space analog to the contralateral side. Such adjustments can also be made with orthodontic measures in advance of prosthodontic treatment, and to avoid unsatisfactory esthetic results they should not be omitted. Alterable esthetic results might be expected in children and juveniles with incomplete growth. However, since there is no splinting of abutment teeth with single-retainer RBFDPs there is also no age limit for this treatment in young patients.

Before clinical diagnosis, the hard and soft tissue conditions should be assessed critically to help inform the patient of possible measures for enhancing the pontic area at an early stage.

Pre-prosthetic treatment

Besides the general pre-prosthetic treatment as at the beginning of any prosthodontic rehabilitation to establish healthy dental and periodontal conditions as well as to implement adequate oral hygiene, certain esthetic considerations have to be taken into account. First is the creation of an anatomically correct as well as symmetrical width of the edentulous space and sufficient lingual space by minor orthodontic measures. Then the soft tissue conditions in the contact area of the planned pontic have to be optimized. Depending on the initial situation, this can be done either by just shaping the local gingiva or in cases with soft tissue defects by placing a subepithelial connective tissue graft. The esthetic result as well as the hygienic pontic design can be improved significantly by performing such minor surgical interventions.

Wax-up and diagnostic preparation

A removable wax-up is fabricated on the diagnostic cast (Fig 3). This wax-up is removable to allow try-in in the patient's mouth. During intraoral try-in, the labial extension of the enamel preparation in the connector area is determined via the wax-up. Additionally, any changes to the adjacent teeth planned in the wax-up can be transferred to the patient using thermoformed splints or silicone molds and can be carried out via composite resin fillings. A secure canine guidance, a harmonious incisal edges outline, or an optimal shape of the proximal contact area can be achieved easily using this technique.

Tooth preparation and impression taking

After try-in of the wax-up and checking it with the patient for acceptance, it is used to outline the extension of the planned preparation in the proximal area. The lingual and proximal enamel surfaces of the abutment tooth are colored using a water-resistant felt pen. After coloring, the wax-up is repositioned in the patient's mouth and a fine dental probe is used on the labial aspect to trace a thin line in the color marking in the proximal area. With this line the precise extension of the planned proximal contact and the proximal extension of the tooth preparation are determined. A silicone mold based on the wax-up can also be used, but attention should be paid to the precise shaping of the silicone mold in the proximal contact area when using this technique.

The retainer wing preparation simply consists of a lingual veneer preparation, a fine cervical chamfer, a fine incisal finishing shoulder, a groove on the cingulum, and a small proximal box preparation (approximately 2 × 2 × 0.5 mm) (Fig 4).[13] The outer limits of the enamel preparation are performed as the first step. In the proximal area, the finishing line has to be positioned lingually and must not cross the traced line of the proximal contact. In the second step, a groove on the central part of the lingual enamel surface is prepared using a ball-shaped bur, and the proximal box is prepared using a chamfer bur. Finally, sharp edges are smoothed and the remaining unprepared parts of the bonding surface are superficially prepared (30 to 50 µm) for optimal bond strength to the enamel surface.[14] The indicated preparation provides the seating of the restoration but no mechanical retention.

Temporary restoration of the prepared tooth is not necessary, but the position of the adjacent teeth should be retained by any means. Impressions can be made using a polyvinyl siloxane or a polyether impression material.

A zirconia ceramic framework is constructed in the dental laboratory and milled with the help of a computer-aided design/computer-assisted manufacture (CAD/CAM) system. The minimum thickness of the retainer wing must not fall below 0.5 mm under any circumstances, and the ideal minimum thickness is 0.7 mm. The proximal connector size should be no less than 3 mm (vertically) × 2 mm (horizontally).

Insertion

The final veneering of the zirconia framework is followed by the final clinical try-in. The accuracy of fit, marginal adaptation of the retainer wing, esthetics, and the proximal contact should be checked carefully.

Fig 4 Preparation of the left central incisor as abutment (with leftover color marking).

The bonding surface can be conditioned once the restoration is accepted after checking. The surface of the proximal veneering ceramic is shielded with a provisional resin coating (eg, Pattern Resin, GC, applied with a brush technique), and the bonding surface of the retainer wing is colored with a felt-tip pen to check the air-abrasion process visually (Fig 5).[15] Unlike metal surfaces, there is no visible change to the naked eye on the zirconia ceramic surface while air-abrading with 50 µm alumina particles at 1.0 bar pressure (Fig 6). To remove remnants of aluminum oxide, ultrasonic cleaning in 99% isopropyl alcohol is carried out.

The abutment tooth as well as the other adjacent tooth next to the edentulous space are kept dry using rubber dam, and cleaned with an air-polishing system using a water-soluble sodium bicarbonate cleaning powder (Fig 7). The bonding surface of the abutment tooth is etched with 36% phosphoric acid for 30 to 60 seconds (Fig 8), rinsed with water spray, and air dried.

Subsequently, RBFDPs are bonded using proven autocuring composite resins such as Panavia 21 TC (Kuraray), or phosphate monomer–containing primers such as Monobond Plus (Ivoclar Vivadent) combined with a composite resin cement, which is applied directly onto the air-abraded bonding surface of the retainer wing (Fig 9).

The composite resin is spread onto the bonding surface of the retainer wing, and this is positioned on the etched enamel surface and held in position until the composite resin has set. If necessary, a splint seated

Fig 5 RBFDP with colored bonding surface (blue) and provisional resin coating (red).

Fig 6 RBFDP after air-abrasion of the retainer wing.

Fig 7 Enamel surface with rubber dam positioned.

Fig 8 Etching with phosphoric acid.

Fig 9 Spreading the phosphate monomer containing composite resin on the retainer wing.

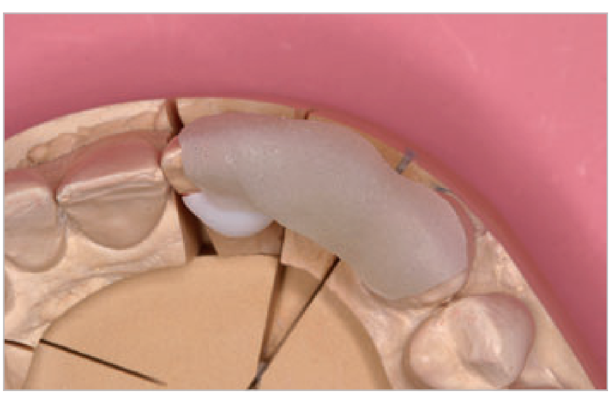

Fig 10 Incisal splint for correct positioning of the RBFDP.

Fig 11 RBFDP directly after insertion.

on the incisal edges (Fig 10) can be used to position the RBFDP reliably.

Excess resin material is removed and an oxygen barrier gel is applied onto the margins. Once the composite resin has fully cured, the occlusion is checked and the patient is instructed regarding adequate oral hygiene with regard to the restoration (Fig 11).

Recall

A recall appointment should be scheduled 2 to 14 days after bonding for a short check and to take an alginate impression of the treated arch for archiving a cast. Especially in young patients this cast might help to detect movement of teeth at an early stage and to fabricate a retainer if necessary. The patient subsequently joins a regular recall plan (Figs 12 to 14).

Fig 12 RBFDP after 2 years of clinical service.

Fig 13 RBFDP after 3 years of clinical service.

Fig 14 RBFDP after 4 years of clinical service.

DISCUSSION

A long-term study published in 2011 showed survival rates for single-retainer all-ceramic RBFDPs of 94.4%[16] after 10 years of clinical service. Data in this study refer to RBFDPs made from glass-infiltrated alumina ceramic. The failures in this study were fractures of the alumina ceramic framework. This emphasizes the point of using zirconia ceramic as framework material. The clinical outcome of single-retainer RBFDPs made from zirconia ceramic has also been reported. A randomized controlled clinical trial showed a 5-year complication-free rate of 93.3%,[17] including traumatic debondings, calculated according to Kaplan-Meier.[18] The survival rate regarding the permanent loss of clinical function or the loss of the RBFDP itself was 100%[17] in this study. In another study with zirconia ceramic RBFDPs made according to the same procedure described above, the survival rate after 6 years of service was 100%, or 95.2% when including complications concerning debondings (unpublished data, 2013).

A survival rate of 100% after 6 years was also recently reported with single-retainer RBFDPs made from lithium disilicate ceramic (e.max Press, Ivoclar Vivadent). The proximal connector size of these lithium disilicate RBFDPs was due to the specific properties of the material, although this was about 2.6 times larger than the connector sizes of zirconia RBFDPs.[12] As long as the specific properties of lithium disilicate ceramic are taken into account, RBFDPs made from this material seem to be a promising treatment option.

Regarding the clinical outcome of single-retainer all-ceramic RBFDPs, good results can be found in the scientific literature, making this a viable treatment modality in dental practices and not only specialized clinics.

To maximize the chance of a successful, esthetic, and minimally invasive treatment, the correct indications must be present. This prerequisite given, single-retainer RBFDPs made from zirconia ceramic are a fast and safe treatment option with a proven, good clinical outcome (unpublished data, 2013).[17] When following a suitable clinical procedure, the survival rate of the RBFDPs is comparable to conventional FDPs. In the few cases in which debonding occurs, the RBFDP can usually be rebonded as long as the initial preparation is correctly limited to the enamel (unpublished data, 2013).[17] An increased risk of caries or periodontitis could not be ascertained in any of the studies. In addition, subsequent conventional as well as implant-retained treatment options remain open without limitation.

REFERENCES

1. Kern M, Kerschbaum T. Adhäsivbrücken. Gemeinsame Stellungnahme der DGZPW und DGZMK. Dtsch Zahnärztl Z 2007;62:621–623.
2. Rochette AL. Attachment of a splint to enamel of lower anterior teeth. J Prosthet Dent 1973;30:418–423.
3. Howe DF, Denehy GE. Anterior fixed partial dentures utilizing the acid-etch technique and a cast metal framework. J Prosthet Dent 1977;37:28–31.
4. Livaditis GJ, Thompson VP. Etched castings: An improved retentive mechanism for resin-bonded retainers. J Prosthet Dent 1982;47:52–58.
5. Livaditis GJ. Cast metal resin-bonded retainers for posterior teeth. J Am Dent Assoc 1980;101:926–929.
6. Hopkins C. An immediate cantilevered Rochette bridge. Br Dent J 1981;151:292–295.
7. Shaw MJ, Tay WM. Clinical performance of resin-bonded cast metal bridges (Rochette bridges). Br Dent J 1982;152:378–380.
8. Kern M, Knode H, Strub JR. The all-porcelain, resin-bonded bridge. Quintessence Int 1991;22:257–262.
9. Kern M, Strub JR. Bonding to alumina ceramic in restorative dentistry over up to five years. J Dent 1998;26:245–249.
10. Kern M, Gläser R. Cantilevered all-ceramic, resin-bonded fixed partial dentures. A new treatment modality. J Esthet Dent 1997;9:255–264.
11. Kern M. Clinical long-term survival of two-retainer and single-retainer all-ceramic resin-bonded fixed partial dentures. Quintessence Int 2005;36:141–147.
12. Sailer I, Bonani T, Brodbeck U, Hämmerle CHF. Retrospective clinical study of single-retainer cantilever anterior and posterior glass-ceramic resin-bonded fixed dental prostheses at a mean follow-up of 6 years. Int J Prosthodont 2013;26:443–450.
13. Kern M. Einflügelige Adhäsivbrücken und Adhäsivattachments: Innovation mit Bewährung. Zahnärztl Mitt 2005;95:2878–2884.
14. Wirz J, Besimo C, Schmidli F. Verbundfestigkeit von Metallgerüst und Haftvermittler in der Adhäsivbrückentechnik. Teil II: Elektrolytische Ätzung von zwölf Nichtedelmetallegierungen. Schweiz Monatsschr Zahnmed 1988;98:944–952.
15. Kern M. Controlled airborne-particle abrasion of zirconia ceramic restorations. J Prosthet Dent 2010;103:127–128.
16. Kern M, Sasse M. Ten-year survival of anterior all-ceramic resin-bonded fixed dental prostheses. J Adhes Dent 2011;13:407–410.
17. Sasse M, Kern M. CAD/CAM single retainer zirconia-ceramic resin-bonded fixed dental prostheses: clinical outcome after 5 years. Int J Computerized Dent 2013;16:109–118.
18. Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. J Am Statist Assoc 1958;53:457–481.