Replacement of two missing adjacent teeth with two single-retainer resin-bonded fixed dental prostheses with improved proximal design

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Purpose: To present a minimally invasive treatment approach for the replacement of two missing adjacent teeth with two single-retainer resin-bonded fixed dental prostheses (RBFDPs). Materials and Methods: Two missing adjacent premolars were restored by two RBFDPs with an innovative design of the proximal section. Both RBFDPs were digitally designed and milled from monolithic 3Y-TZP zirconia ceramic using CAD/CAM technology. Following the construction of the anterior RBFDP, a shallow interlock was designed in the area of the proximal contact, which was applied in the same insertion direction as the posterior RBFDP. In this way, different paths of insertion of the RBFDPs could be compensated without reducing the proximal hygiene capability. Results: The presented minimally invasive restorations were successful over 3 years of clinical observation without any complications. Conclusion: The presented restoration design secures the transversal position of the RBFDPs while maintaining the physiologic tooth mobility. In addition, it allows the compensation of varying paths of insertion while improving hygienic conditions. Last, in case of a unilateral debonding of one retainer wing, rebonding might be possible. Int J Prosthodont 2022. doi: 10.11607/ijp.7711

Introduction
For the replacement of two missing adjacent teeth, conventional fixed dental prostheses (FDPs) are a reliable long-lasting treatment method [1]. With conventional crown-retained FDPs, the necessary loss of substance due to the preparation of the abutment teeth is high compared to minimally invasive restorations [2, 3]. The risk of vitality loss and the
development of apical lesions, as well as the risk of secondary caries at the crown margin, increased in long-term observations [4]. Nowadays, the alternative are implant retained crowns with promising long-term results [5]. In elderly patients with inadequate quantity of bone for implant placement, the required augmentation procedure and the invasiveness of the procedure often might prevent patients to choose implants as therapy. RBFDPs present an alternative to the above invasive treatment methods. Single-retainer zirconia ceramic RBFDPs in the anterior region showed excellent long-term results [6]. As short-span single-retainer metal-ceramic RBFDPs exhibited also promising long-term in the posterior area [7], posterior short-span single-retainer zirconia might also be a valid treatment option.

In contrast to tooth replacement with conventional crown-retained FDPs, much sound tooth structure of the abutment teeth is preserved when applying RBFDPs. Using two separate single-retainer RBFDPs to replace two missing adjacent teeth might result in the following advantages:
- Preserving the physiological mobility of the abutment teeth
- Reducing the stress and the bonding interfaces caused by splinting in a two-retainer design
- Allowing varying paths of insertion for the RBFDPs, i.e. resulting in reduction of undercut areas that otherwise need to be removed by preparation of considerable amount of sound proximal enamel.
- In case of unilateral debonding of a RBFDP, rebonding might be easier.
- The use of minimally invasive RBFDPs permits later use of all conventional treatment options such as crown-retained FDPs and implant-retained crowns.

In the following case report the concept of segmented single-retainer RBFDPs in the posterior area with a follow-up of 3 years is presented.

Case report
A 68-year-old female patient presented herself with an edentulous gap in the region of the maxillary right premolars replaced with a removal partial denture(Figure 1). The edentulous space of the missing premolars had a reduced width of about 11 mm. In addition, the first left premolar in the maxilla and the first left premolar in the mandible were also missing with closure of gaps by tooth migration or orthodontic treatment. In the mandible, all fixed prosthetic restorations were in clinically acceptable conditions and showed no noticeable defects (Figure 2).

The removal partial prosthesis in the maxilla showed inadequate retention. The retentive clasp on the canine was fractured, so that prosthesis retention was compromised.
The patient was healthy. The radiographic examination of the prospective abutment teeth showed no sign of bone resorption or periapical pathology. The dentition showed no
increased mobility, both abutment teeth were vital and probing depths were not greater than 3 mm.

Treatment planning and preparation
The conventional treatment options with crown-retained FDPs and implant-retained crowns were described and discussed with the patient. According to her statement, she had a negative attitude towards dental implants based on mainly negative reports from her circle of friends. The referring general dentist advised her against replacing both premolars with a conventional FDP due to invasiveness, since the canine in particular was completely sound. The patient refused to receive a replacement of the adequate conventional crown on the first molar and asked for a bonded restoration instead. Based on the unfavorable performance of two-retainer RBFDPs in the molar region [8] and the 11 mm gap width, the patient opted to receive two single-retainer RBFDPs [9].

The planned preparation was first performed on a study cast and then transferred intraorally. The two abutment teeth were marked with a black water-resistant felt pen (Multimark 1513 permanent F; Faber-Castell, Stein, Germany), and the static and dynamic contacts were marked with occlusion foil (Arti-Fol 8 µ; Bausch, Cologne, Germany) [2].

The preparation was performed with a fine-grained diamond bur on the canine tooth limited to the enamel. By removing only the color of the previously colored surface, it was possible to ensure that the preparation was only made in the superficial enamel. The preparation was extended over the entire lingual surface distally into the proximal region. Correspondingly, the metal-ceramic crown of the molar was prepared within the veneering ceramic. The preparation extended from the lingual area to the buccal area in the proximal direction. A minimum connector height of 3 mm was obtained and care was taken to ensure a 0.7 mm minimum thickness of the retainer wing. During the preparation of the molar, care was also required to limit this only in the veneering ceramic (Figure 3). The impression was taken with polyether material (Permadyne; 3M ESPE, Neuss, Germany).

Digital design of the restorations
After the casts were completely scanned (D900, 3Shape, Copenhagen, Denmark) and DentalDesigner 2017 (3Shape) software was used to create the digital design (Figure 4). At first, the anterior RBFDP was designed. The retainer wing for the canine was constructed with a thickness of at least 0.7 mm and a connector dimension of 20 mm². Then, the premolar pontic was designed in full shape ('crown pontic'). A shallow interlock was created in the interproximal contact area in a slightly mesially inclined position occlusal to the contact point with the aid of a cylinder out of the 'holes' group selected in the 'attachment' tool (Figure 5).
The digitally designed anterior RBFDP was milled with a CAM machine (Zenotec select hybrid; Wieland Dental, Pforzheim, Germany) from monolithic 3Y-TZP zirconia ceramic (Katana Zirconia ML; Kuraray Noritake, Osaka, Japan) and then sintered to full density (P 310 furnace; Nabertherm, Lilienthal, Germany). After that, the RBFDP was adapted to the plaster cast and polished.

After scanning the anterior part on the cast, the construction of the posterior RBFDP was performed. The retainer wing of the posterior RBFDP was extended occlusally according to the preparation to provide a vertical support of at least 3 mm and had a connector dimension of about 25 mm² (Figure 6). The construction of the proximal contact surface of the two pontics was a challenge, since the software did not provide adjustable parameters for designing this special contact surface between the two pontics. In keeping with a smaller gap width, in the present case it was advisable to design two premolars, each 5.5 mm wide, for a gap width of 11 mm. For a smaller gap width, the design of a split molar is also possible [9].

After milling and sintering, the posterior RBFDP was adapted to the model with the anterior RBFDP in place, and polished (Figure 7). To allow dental floss to pass through the contact surface of the two pontics, the occlusal edges of the pontic parts were slightly rounded (Figure 8).

**Insertion of the restorations**

In preparation for adhesive luting, rubber dam was applied (Figure 9). After that, the surfaces were cleaned and the correct positioning of the RBFDPs was practiced. The bonding surfaces of the restorations were air-abraded with 50 µm alumina particles at 0.1 MPa pressure and cleansed in isopropanol afterwards. The enamel of the canine tooth was etched with 37% phosphoric acid for 30 s then thoroughly rinsed with water spray and dried. The veneering ceramic of the crown was cleaned with 37% phosphoric acid for 30 s, then etched with hydrofluoric acid for 60 s and a silane was applied (Ultradent Porcelain Repair Kit, Ultradent Products Inc., Cologne, Germany).

Both RBFDPs were inserted simultaneously using a phosphate monomer containing adhesive luting resin (Panavia 21TC; Kuraray Noritake, Osaka, Japan). After that the occlusion was checked and a vacuum-formed occlusal splint was fabricated to be used by the patient as a night guard. About one week after placement, the patient was called again for a check-up. She was able to clean the proximal surfaces with dental floss in particular without any problems. The patient is still very satisfied to have chosen this treatment and appears once a year for a follow-up examination (Figure 10-12).

**Discussion**

The presented clinical case describes the minimally invasive replacement of two missing adjacent premolars with a gap width of 11 mm using two single-retainer RBFDPs. The
RBFDPs were adhesively bonded after minimally invasive preparation. Based on the currently published data, a very good long-term performance of single-retainer RBFDPs in the anterior and premolar region can be assumed. Nevertheless, the data available for RBFDPs in the posterior region is only moderate compared to RBFDPs in the anterior region [7, 10, 11]. This treatment option appears to be superior to a splinted two-retainer design, which has a high risk of unilateral debonding due to stresses caused by the physiological mobility of the abutment teeth. The resulting mobility of the abutment teeth seems to have a more positive long-term effect on the survival of such restorations than rigid fixation of both abutment teeth by the restoration [12]. In 2019, Lam et al. were able to show 10-year data of posterior fixed-movable resin-bonded fixed partial dentures (cumulative survival rate 64.4%) [12]. In this study, mainly technical complications influenced the outcome (debonding in three quarters of all restorations). In addition to the negative influences revealed in the study (molar width of the cantilever and restoration in the posterior region), the design of the proximal connector could probably also have an influence on the outcome. Considering the fact that the designed interlocking in this case report consists of completely rounded structures without sharp edges with an estimated precision of 20-30 µm between the two parts, an independent mobility of both abutment teeth within its physiological range is provided [13]. Therefore, it is not expected that this specific design of the proximal region results in increased tensions during differential movements of the abutment teeth, that would affect the bonding of the RBFDPs.

A particular risk is the uncertain prognosis of the conventional crown on the molar. The patient was given comprehensive advice of the various treatment alternatives during the planning of the restoration. A newly cemented restoration on the first molar might have had advantages over bonding on veneering ceramics in terms of physical stability. However, the existing restoration on the first molar was clinically adequate and, taking into account possible complications with a new restoration with a conventional crown and the expected additional costs for this type of restoration, the patient decided against crown replacement. Due to the above-mentioned uncertainties and the question of the long-term stability of the bond between the veneering ceramic and the metal framework of the existing restoration with regard to possible age-related microcracks in the veneering ceramic, the long-term stability of the adhesive bond to the distal RBFDPs remains to be seen. In the worst case scenario, if the distal RBFDP fails, a new distal RBFDP could be fabricated and bonded due to the special design of the anterior restoration. If the anterior RBFDP is maintained, a new restoration of the first molar with a conventional crown with a mesial cantilever is also a conceivable option. Since the concerns regarding the longevity of the restoration mainly relate to the distal RBFDPs, the design was chosen in such a way that the distal RBFDPs can be newly fabricated. The innovative design of the approximal area allows physiological
mobility of the abutment teeth without stress due to torsion on the bonding surfaces. Should the distal RBFDP become detached in the further course of the restoration, the chosen design allows it to be re-bonded without any problems. If, contrary to expectations, there is an indication to reconstruct the anterior RBFDPs, it may be necessary to modify the proximal design intraorally in such a way that a new restoration can be placed here as well. The special design of the proximal space can also compensate severe undercuts [9]. In the event of long-term failure of both restorations, the patient is left with all conventional treatment options, as this is a minimally invasive preparation on both teeth.

The method described is a technique-sensitive treatment option. The digital design of the restoration is demanding, as the currently available systems do not allow a standardized design. The shallow interlock should be designed in such a way that rotation of the abutment teeth is not possible and also flossing and rebonding are possible when required. Similar to the digital design, the precise procedure during bonding is also quite challenging.

To date, the patient is very motivated and her oral hygiene is good. At the patient's request, professional teeth cleaning is performed at regular appointments with her family dentist at her place of residence. Nevertheless, to ensure the long-term success of the restorations, their annual check-up is recommended.

REFERENCES

Fig 1 Occlusal view of the removal partial prosthesis in the maxilla. The maxillary right first molar was already restored with an adequate metal-ceramic restoration, the maxillary right premolars and the right second molar were replaced by the removal partial denture, which had been worn for about 15 years.

Fig 2 Occlusal view of the mandible. In the mandible, the missing premolars on the right were replaced with an FDP, and the second molar on the right was restored with a crown.

Fig 3 Final preparation of both abutment teeth. Particular attention was paid to rounding off possible sharp edges. Proximally, the undercuts were reduced only minimally until an adequate connector height for the RBFDPs was achieved.

Fig 4 Detailed view of the scanned plaster model with the final preparation of the abutment teeth. The extension of the retainer wings was previously marked in red.

Fig 5 Construction of the anterior RBFDP with a sloping vertical groove with a cylinder out of the ‘holes’ group

Fig 6 Digital design of the posterior RBFDP

Fig 7 Occlusal view of the finished RBFDPs

Fig 8 Detailed view of the proximal space of the distal RBFDP. Sharp edges have been rounded for easier hygiene.

Fig 9 Accurate application of rubber dam before conditioning the different substrates before bonding.

Fig 10 Occlusal view of the inserted restorations

Fig 11 Labial view of the two single-retainer RBFDPs 3 years after insertion

Fig 12: Occlusal view 3 years after insertion