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Retention silicone to restore stability in removable partial dentures – a case study

Summary: Retention silicones can be used for temporary anchoring of removable dentures on root-anchored ball attachments. From a geriatric point of view, they offer the possibility of a quick and cost-effective improvement of the position stability and retention of the removable dentures. Clinical studies are however required to elucidate the long-term performance of these materials.

Keywords: removable dental prosthesis; double-crown; root-anchored ball attachment; retention silicon; complication; repair

Introduction

Edentulous arches in Germany are often and regularly treated with removable dentures. According to data of the Fifth German Oral Health Study (DMS V), 71.8 % of older seniors between ages of 75–100 years are provided with removable dentures. The most common form of partial denture is the combined permanent removable denture, with 23.9 % in the upper jaw and 36.3 % in the lower jaw [10]. Double crowns are mainly used as retention elements. They apply as a rather expensive treatment option initially, but offer advantages of a mechanically stable retention, good oral hygiene and easy expandability, as well as cheap repair options for removable dentures [15].

The most commonly observed technical complications in double crown anchored dentures are the decementations of primary crowns with 26.0 % in parallel walled double crowns and 18.6 % in conic double crowns as well as fractures of veneers after an observation period of 7 years [5]. The latter occurs after an observation period of 12 years with a probability of 18.4 % [29]. The survival rate of tooth-anchored double crowns after 4.0 to 5.3 years lies between 90.0 and 95.1 % [17], but biological complications such as periodontal inflammation, carious lesions or fractures can cause the loss of abutment teeth or the need for endodontic measures [29]. After an observation period of 8 years 37.0 % of the abutment teeth showed an increased mobility and 1.3 % of abutment teeth fractured [30]. Endodontic treatment impairs the prognosis of the abutment tooth [27], but can lastly also contribute to the preservation of the tooth, while advanced bone loss and the resulting increased mobility and fractures regularly cause the loss of the tooth.

The loss of an abutment tooth in double crown anchored dentures impairs the denture's function regularly, especially when the extraction causes unilateral burden on the remaining abutment teeth [20]. A typical example is a unilateral loss of the distal abutment of a patient with Kennedy Class I. In this setting the available therapy options are usually limited and normally require a complex new prosthetic restoration – provided that implantological options are unavailable. If an implantation is possible, different possibilities for prosthetic rehabilitation are available. The integration of pre-assembled anchoring elements in existing and double crown anchored dentures is difficult and bears the danger of complicated handling for the patient, because 2 different anchoring elements are combined with each other. Furthermore, an excessive wear of the anchoring elements can be expected. For this reason individually produced implant abutments are often inserted in such cases, and implanted in the previous position of the abutment tooth. After the implant has healed with a double crown, it is then inserted in the existing denture [24]. Especially older seniors are critical towards implantation. According to studies the emerging costs, associated effort and the possible complications of the surgical procedure are seen as

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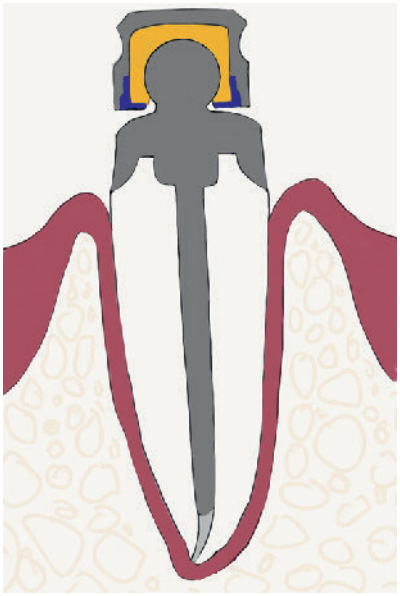

Figure 1 Schematic illustration of an root-anchored ball attachment with ball-shaped head and retention element

Figure 2 Initial intraoral situation

problematic [11, 19]. For these reasons an implantation in elderly patients is regularly not an option. Additionally, the post prosthetic treatment and care of implants by patients is not always guaranteed.

The preservation of compromised teeth treated with double crowns is often clinically reasonable or necessary in order to stabilize the existing dentures at least temporarily or to avoid an adaptation or an extended new restoration. For these reasons even in cases with fractured abutment teeth treated with double crowns an endodontic therapy should be taken into consideration, despite the impaired prognosis. The chairside restoration with a root pin of a fractured abutment tooth is seldom possible satisfactorily, because an exact repositioning of the primary crown is difficult due to the regularly missing ferrule effect. Under a load it can lead to pin and/or root fractures as well as decementation of the core-abutment buildup [6]. Modified post systems such as the direct treatment with a Würzburger post or the indirect preparation of a root-anchored ball attachment in a dental laboratory are supposed to minimize complications and failures that often occur in classic treatments of endodontically treated abutment teeth with core-abutment build up [23]. The root-anchored ball attachment manufactured indirectly is understood as a patrix located slightly supragingival or epigingival, following the original root anatomy (Fig. 1). It is anchored on a metal core in the root canal and is fitted with a retention element in the supragingival part. The latter provides a bond to the matrix, which in turn is incorporated in the denture. The patrix and matrix of root-anchored ball attachments can be designed differently. For the patrix a ball-shaped head (e.g. Dalbo-System, Cendres et Métaux, Biel, Switzerland) or a screwed cylinder form (e.g. Gerber retention cylinder) is described. Conod- oder Bona cylinder anchors, which generate their support through friction, are less recommendable due to their impaired retaining forces [28]. Especially the ball abutment has been clinically proven, it is characterized by easy cleaning and technically simple follow-up care [7]. The matrix is polymerized into the base of the denture. The retention effect of the patrix in turn occurred through activated blades, retention elements based on polyoxymethylene, or composite or spring rings.

Ball-shaped heads regularly find applicability as retention elements in push-button systems and implant-anchored removable overdentures. This often results in retention losses due to wear [7, 9, 12, 13]. Furthermore, retention silicones based on polyvinyl siloxane can be used to fixate overdentures at least temporarily on retentive abutments, such as in phases of implant healing [18]. Laboratory investigations could show that such systems have the potential to secure satisfactory retention of removable dentures for a longer period of time. Concerning their stability and retention force, they were comparable with classic push-button systems like locators [26]. Based on these investigations it should be considered if these retention silicones in combination with root-anchored ball attachments can be used as the easiest method in order to guarantee the retention of removable dentures in fractured abutment teeth. With that in mind, the present case study describes the application of a retention silicone in combination with a root-anchored ball attachment in a patient with insufficient retained double crown anchored dentures in the lower arch.

Case presentation

A 78-year old patient presented himself in the interdisciplinary patient

Figure 3 Occlusal view of inserted denture with ring telescope on tooth 47 and with a secondary part of a previous ring telescope filled up with composite to replace tooth 46

Figure 4 Occlusal view without inserted denture with a primary part of a ring telescope on tooth 47

admission of the university hospital Leipzig. The general anamnesis showed hypertension as well as adequately controlled diabetes mellitus type 2. The patient reported to have been provided with removable dentures since 2008 in the lower arch, and that the fit of the dentures has been poor for about a year. Because of this the dentures have been repaired and modified multiple times, but a significant improvement has not occurred to date.

The extraoral examination showed no abnormalities. Intraorally, the patient presented a conserved and prosthetically treated residual dentition. The oral mucosa was clinically normal. The tongue presented its standard variation with a lingua plicata. In the upper arch the tooth 17 was missing, whereas the lower arch was treated with removable dentures that replaced the teeth 35, 36, 37 and 46. The tooth 47 was treated with a ring telescope. The anchoring tooth 33 showed a clinically sufficient, seemingly free modulated root-anchored ball attachment (diameter of the ball-shaped head was about 2 mm) and healthy periodontal conditions (probing depth < 3.5 mm on all 6 measuring points, no bleeding on probing) (Fig. 2–4). The secondary crown in removable dentures in the region of tooth 33 was filled with chewing gum. Upon request, the patient states that he optimized the unsatisfactory retention himself with the application of chewing gum, after the pink silicone inserted repeatedly by the dentist was lost regularly. He renewed the chewing gum every three days. The dentures showed multiple repair sites and significant signs of wear. The patient explained further that the anchor strap crown in region of tooth 46 was rebuilt with composite after extraction and the denture had been relined repeatedly. Clinically, the retention of the denture was diagnosed as insufficient. Due to the lining of the outer telescope on tooth 33 with chewing gum, the removable denture was only supported selectively in region 47, which explained the insufficient retention and position stability. No pressure points could be identified within the clinical examination; the static and dynamic occlusion could be categorized as clinically sufficient. In a functional respect a brief report showed no pathological abnormalities. The dentures were covered in firm biofilm in localized areas (Fig. 5); intraorally, a clinically acceptable oral hygiene was seen. In a periodontal context, a pretreated dentition was seen. The patient reported to participate in periodontal therapy regularly.

Figure 5 View of the base of the removable denture and a secondary part filled with chewing gum in the region of tooth 33 and a ring telescope on tooth 47

The orthopantomogram (OPG) showed generalized horizontal bone loss in the upper arch, as well as localized vertical dips mesial of tooth 33, which could not be probed clinically (Fig. 6). The tooth showed a radiological sufficient root filling and was treated with a tight root-anchored ball attachment. The bone structure in total was homogenous. No periapical lesions could be identified.

With regard to the dental functional capacity, the patient was grouped into ruggedization level 1; and there were no constraints in therapy effectiveness, oral hygiene and personal responsibility [4]. However, the patient refused extended modifications as well as a complex new fabrication of the dentures and wanted a temporary improvement of the dentures retention. For this reason, it was decided in a conversation with the patient to insert retention silicone to improve retention of the removable dentures in the region of the secondary crown on tooth 33.

First, a situation impression was fabricated using a partial impression tray which surrounds the root-anchored ball attachment without inserted removable dentures (Image Fast Set, Kerr Dental GmbH, Biberach, Germany) and a plaster model was made. In the second session a partial reline impression with condensation-linked silicone (Xantopren comfort light, Kulzer, Hanau, Germany) and a pick-up impression with alginate (Image Fast Set, Kerr Dental GmbH, Biberach, Germany) was manufactured to extend the vestibular and lingual prosthetic components in the region 33 (Fig. 7). According to manufacturer specifications, the used retention silicone adheres only to polymethylmethacrylate (PMMA), and the outer telescope was milled for sufficient retention on the prosthetic body, filled with PMMA (Probase, Ivoclar Vivadent AG, Schaan, Lichtenstein) and the area was hollowed out using the situation model so that a large enough cavity was created to uptake the root-anchored ball attachment which simultaneously guaranteed a circular minimum layer thickness retention silicone of 1 mm. A complex customizing with milling the dentures chairside could be avoided due to the situation model created earlier. The base of the denture in regio 33 was modified in this manner using corundum blasting (110 µm aluminium oxide, 3 bar) and afterwards conditioned with a bonding agent (Multisil Primer, Bredent, Senden, Germany) according to manufacturer specification. The material in the present case (retention.sil, Bredent, Senden, Germany) is available in different retention strengths. According to the instruction manual of the materials used, the shore hardness amounts to either 25, 50 or 65 shore, while the pull-off forces can amount up to 2.4 or 6 Newton. Medium retention strength (retention.sil 400, Bredent, Senden, Germany) were used. Because tooth 33 was periodontally healthy, no pre-prosthetic periodontally prophylactic measures were necessary and the retention silicone was inserted chairside in the previously conditioned cavity in the base of the dentures and the root-anchored ball attachment according to manufacturer specification (Fig. 8). According to the instructions, it was not necessary to isolate the dentures beforehand. The dentures were subsequently inserted in the patient's mouth. The polymerization of the material took place intraorally for a period of 15 min in an occluded state. Afterwards, the dentures were extracted, the excess was removed with a scalpel and the insertion and removal of the removable dentures was practiced with the patient. Finally, the silicone was not covered with a glazing, because the instructions did not intend for this. Initially, a significant retention improvement and position stability of the dentures was seen. Control examinations were performed after a period of 12 weeks. No signs of wear could be found at either appointments; similarly, no constraints of the adhesion between

Figure 6 OPG from September 2019 shows a sufficient root-anchored ball attachment on tooth 33

Figure 7 Denture after impression for a partial relining with a condensation-linked silicone and pick-up impression with alginate

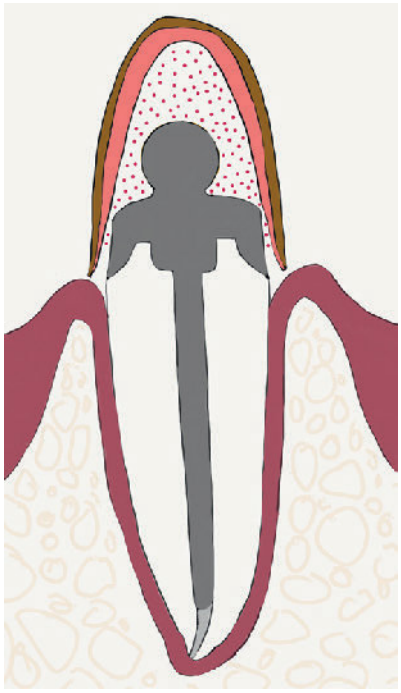

Figure 8 Root-anchored ball attachment treated post prosthetically; the secondary crown (golden) is lined with PMMA (pink) to achieve a connecting retention silicone (depicted dotted)

retention silicone and base of the denture could be identified clinically. The retention and position stability of the denture was satisfactory from both the dentists and patients position. The insertion and removal by the patient was possible without problems (Fig. 9).

Discussion

Fractures in abutment teeth are seen regularly, especially in double crowned dentures. This is particularly problematic when it causes a selectively or unilateral-tangential support of the removable denture. Besides extracting a fractured abutment tooth, these treatment options are often limited in such cases and the root-anchored ball attachment treatment of a damaged abutment tooth has been established. The present case report further illustrates the transfer of a procedure described for removable implant dentures to classic partial prosthetics, in order to anchor root-anchored ball attachments with the existing dentures. In the present case the patient was already treated with a root-anchored ball attachment in region 33, which, however, was used inappropriately to secure periodontal positioning of dentures. A sufficient retention and position of dentures was not given. However, it is known in this context that the retention and position stability of removable dentures affects the oral health-related quality of life of patients wearing dentures [1, 3, 21]. For these reasons different options for improvement of the dentures were discussed with the patient in the present case report; these included the insertion of a new matrix or a completely new prosthetic restoration. The patient emphasized an easy repair that is possible without complex modifications and can restore chewing comfort and retention of the denture temporarily. Because there were regular problems with the formerly inserted push-button system, it was agreed to affect an improvement of retention by inserting a retention silicone in the removable part of the dentures. The clinical and laboratory implementation ran smoothly. Before the application of the retention silicone it is useful to perform an impression of the root-anchored ball attachment, because this way the secondary crown can be prepared for the individual spatial conditions and a complex chairside milling can be avoided. During insertion of retention silicones, bubble formation should be avoided, because it can affect the durability and retention strength of the silicone [25]. According to the authors experiences the excess materials are difficult to remove due to the hardness and elastic consistency after hardening, which is why relevant areas are to be isolated beforehand. Hardened excess materials can be removed with a sharp scalpel, whereas the base of the dentures should not be damaged. Initially and within the 12-week observation period a satisfactory retention and position stability of removable dentures could be achieved. According to the manufacturer's instructions, the used retention silicone in the present case can remain in the mouth for up to 2 years. It remains to be seen if the materials used in a clinical daily routine show similar signs of wear as the soft relining materials (Liner). Silicone-based lines for relining of dentures show better clinical characteristics as liners based on acrylates [8]; however, porosities, discolorations, removal of adhesive bond on the denture base and increased settlement with Candida albicans are described regularly in these materials [14, 16]. The latter applies as one of the main causes for the genesis of denture stomatitis [2] and is therefore of particular clinical relevance. Furthermore, it has to be clarified how long retention silicones can ensure the retention of the dentures in clinical conditions. In laboratory investigations where a denture base was relined with different polyvinyl siloxane to generate a retentive effect of a ball-head attachment, it could be shown that the initial retention power depending on the shore hardness of the polyvinyl siloxane used, lies between 1.3 and 5.4 N [18]. The achievable retention values with the help of such retention silicones range in power of 5.0–7.0 N, which is seen as least necessary to adequately stabilize overdentures [22]. According to the authors no clinical data exists at this time. However, it should be noted that a cost-effective new restoration of the silicone is possible in the sense of a "chairside" concept. In this context it should be highlighted that the usage of retention silicones cannot cause a rigid bearing of the removable dentures based on the elasticity of the material. Clinical complications based on missing axial load on abutment teeth are possible, however, amidst the extraction as an alternative therapy can be seen as unproblematic. Besides the mentioned applicability in this case study for retention silicones, they can also find use in a geriatric setting. The dental care of older and very elderly patients is complex and characterized by different factors. Besides the common issues that involve the individual's tooth status, the patients' wish, as well as financial factors, the dentist is confronted with limited therapy and oral hygiene, as well as missing personal responsibility of the patient. Especially with regard to prosthetic dentures it is commonly shown that quick and cheap variations that only

need slight adaptations of dentures should be preferred over complex reparations or new restorations. In this context especially the availability of retention silicones with different shore hardness could be beneficial to generate different retention powers. Thus, the adjustment of retention power of removable dentures depending on individual dental functional capacity of the patient is possible. In the meantime, industrial prefabricated matrices based on polyvinyl siloxane that are available in different shore hardness were examined in laboratory investigations. The further development is supposed to combine the benefits of retention silicones with the possibility of generating higher retention power [25]. However, in this context clinical results that support the retention stability of prefabricated matrices are still missing.

(Fig. 1–9: E. Pahncke)

Figure 9 Base of dentures 3 months after insertion of the retention silicone, which lines the retentive part of the root-anchored ball attachment and the circular secondary part

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Conflicts of interest

Prof. Dr. Sebastian Hahnel was involved in a third-party funded project with the company bredent (in 2017, Regensburg) as well as another third-party funded project of the Federal Ministry of Economics and Technology or the AIF with the company bredent (in the years: 2016–2019). The other authors declare that there is no conflict of interest as defined by the guidelines of the International Committee of Medical Journal Editors.

References

1. Abdou ELsyad M, Elgamal M, Mohammed Askar O, Youssef Al-Tonbary G: Patient satisfaction and oral health-related quality of life (OHRQoL) of conventional denture, fixed prosthesis and milled bar overdenture for All-on-4 implant rehabilitation. A crossover study. Clin Oral Implants Res 2019; 11: 1107–1117

2. Arendorf TM, Walker DM: Denture stomatitis: a review. J Oral Rehabil 1987; 14: 217–227

3. Awad MA, Lund JP, Shapiro SH et al.: Oral health status and treatment satisfaction with mandibular implant overdentures and conventional dentures: a randomized clinical trial in a senior population. Int J Prosthodont 2003; 16: 390–396

4. Bär C, Reiber T, Nitschke I: Status quo und Ziele der nahen und fernen Zukunft. 2009; www.zm-online.de/archiv/2009/05/titel/status-quo-und-ziele-der-nahen-und-fernen-zukunft/ (last access: 14.01.2020)

5. Behr M, Hofmann E, Rosentritt M, Lang R, Handel G: Technical failure rates of double crown-retained removable partial dentures. Clin Oral Investig 2000; 4: 87–90

6. Boldt J, Rottner K, Richter EJ: Der Würzburger Stift. ZWR 2007; 116: 603–606

7. Büttel AE, Bühler NM, Marinello CP: Locator oder Kugelanker? Eine Hilfe für die klinische Entscheidungsfindung. Schweiz Monatsschr Zahnmed 2009; 119: 901–918

8. Chladek G, Żmudzki J, Kasperski J: Long-term soft denture lining materials. Materials (Basel) 2014; 7: 5816–5842

9. Choi J-W, Yun B-H, Jeong C-M, Huh J-B: Retentive properties of two stud attachments with polyetherketoneketone or nylon insert in mandibular implant overdentures. Int J Oral Maxillofac Implants 2018; 33: 1079–1088

10. Cholmakow-Bodechtel C: Fünfte Deutsche Mundgesundheitsstudie (DMS V). Deutscher Zahnärzte Verlag Köln, 2016

11. Ellis JS, Levine A, Bedos C et al.: Refusal of implant supported mandibular overdentures by elderly patients. Gerodontology 2011; 28: 62–68

12. Engelhardt F, Zeman F, Behr M, Hahnel S: Prosthetic complications and maintenance requirements in locator-attached implant-supported overdentures: A retrospective study. Eur J Prosthodont Restor Dent 2016; 24: 31–35

13. Hahnel S, Alamanos C, Schneider-Feyrer S, Stöckle M, Rosentritt M: Investigation of clinical and laboratory wear in locator-supported, implant-retained overdentures. Int J Prosthodont 2018; 31: 334–337

14. Hashem MI: Advances in soft denture l: an update. J Contemp Dent Pract 2015; 16: 314–318

15. Hofmann E, Behr M, Handel G: Frequency and costs of technical failures of clasp- and double crown-retained removable partial dentures. Clin Oral Investig 2002; 6: 104–108

16. Kang SH, Lee HJ, Hong SH, Kim KH, Kwon TY: Influence of surface characteristics on the adhesion of Candida albicans to various denture lining materials. Acta Odontol Scand 2013; 71: 241–248

17. Koller B, Att W, Strub JR: Survival rates of teeth, implants, and double crown-retained removable dental prostheses: a systematic literature review. Int J Prosthodont 2011; 24: 109–117

18. Kubo K, Koike T, Ueda T, Sakurai K: Influence of the mechanical properties of resilient denture liners on the retention of overdenture attachments. J Prosthet Dent 2018; 120: 431–438

19. Merz MA, Terheyden H, Huber CG, Seixas AA, Schoetzau A, Schneeberger AR: Facilitators and barriers influencing the readiness to receive dental implants in a geriatric institutionalised population – a randomized non-invasive interventional study. Gerodontology 2017; 34: 306–312

20. Moldovan O, Rudolph H, Luthardt RG: Clinical performance of removable dental prostheses in the moderately reduced dentition: a systematic literature review. Clin Oral Investig 2016; 20: 1435–1447

21. Müller F, Duvernay E, Loup A, Vazquez L, Herrmann FR, Schimmel M: Implant-supported mandibular overdentures in very old adults: a randomized controlled trial. J Dent Res 2013; 92: 154S–60S

22. Pigozzo MN, Mesquita MF, Henriques GEP, Vaz LG: The service life of implant-retained overdenture attachment systems. J Prosthet Dent 2009; 102: 74–80

23. Rauch A, Hahnel S, Köthe S, Schierz O: Improving oral health-related quality of life by converting fractured abutment teeth in double crown-retained removable prostheses into root-anchored ball attachments. Int J Prosthodont 2019; 32: 389–392

24. Schweiger J, Güth JF, Edelhoff D, Stimmelmayr M: CAD/CAM-Lösung nach Verlust eines Doppelkronenpfeilers. 2012; www.zm-online.de/archiv/2012/22/titel/cadcam-loesung-nach-verlust-eines-doppelkronenpfeilers/ (last access: 14.01.2020)

25. Schweyen R, Arnold C, Setz JM, Hey J: Retentive characteristics of individual and prefabricated polyvinylsiloxane overdenture attachments: alternative treatment options for geriatric patients. Clin Oral Investig 2019; 23: 1425–1434

26. Schweyen R, Beuer F, Arnold C, Hey J: Retentive characteristics of a vinylpolysiloxane overdenture attachment system. Clin Oral Investig 2015; 19: 947–953

27. Stober T, Bermejo JL, Séché A-C, Lehmann F, Rammelsberg P, Bömicke W: Electroplated and cast double crown-retained removable dental prostheses: 6-year results from a randomized clinical trial. Clin Oral Investig 2015; 19: 1129–1136

28. Strub JR, Kern M, Türp JC, Witkowski S, Heydecke G, Wolfart S: Kombinierte und abnehmbare Prothetik, Implantologie, Nachsorge, Lebensqualität. Quintessenz Verlag, Berlin 2011

29. Verma R, Joda T, Brägger U, Wittneben JG: A systematic review of the clinical performance of tooth-retained and implant-retained double crown prostheses with a follow-up of ≥ 3 years. J Prosthodont 2013; 22: 2–12

30. Walther W: Risk of endodontic treatment after insertion of conical crown retained dentures: a longitudinal study. Endod Dent Traumatol 1995; 11: 27–31

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