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Tailor-made, not off the rack – prime4me® RETAIN3R

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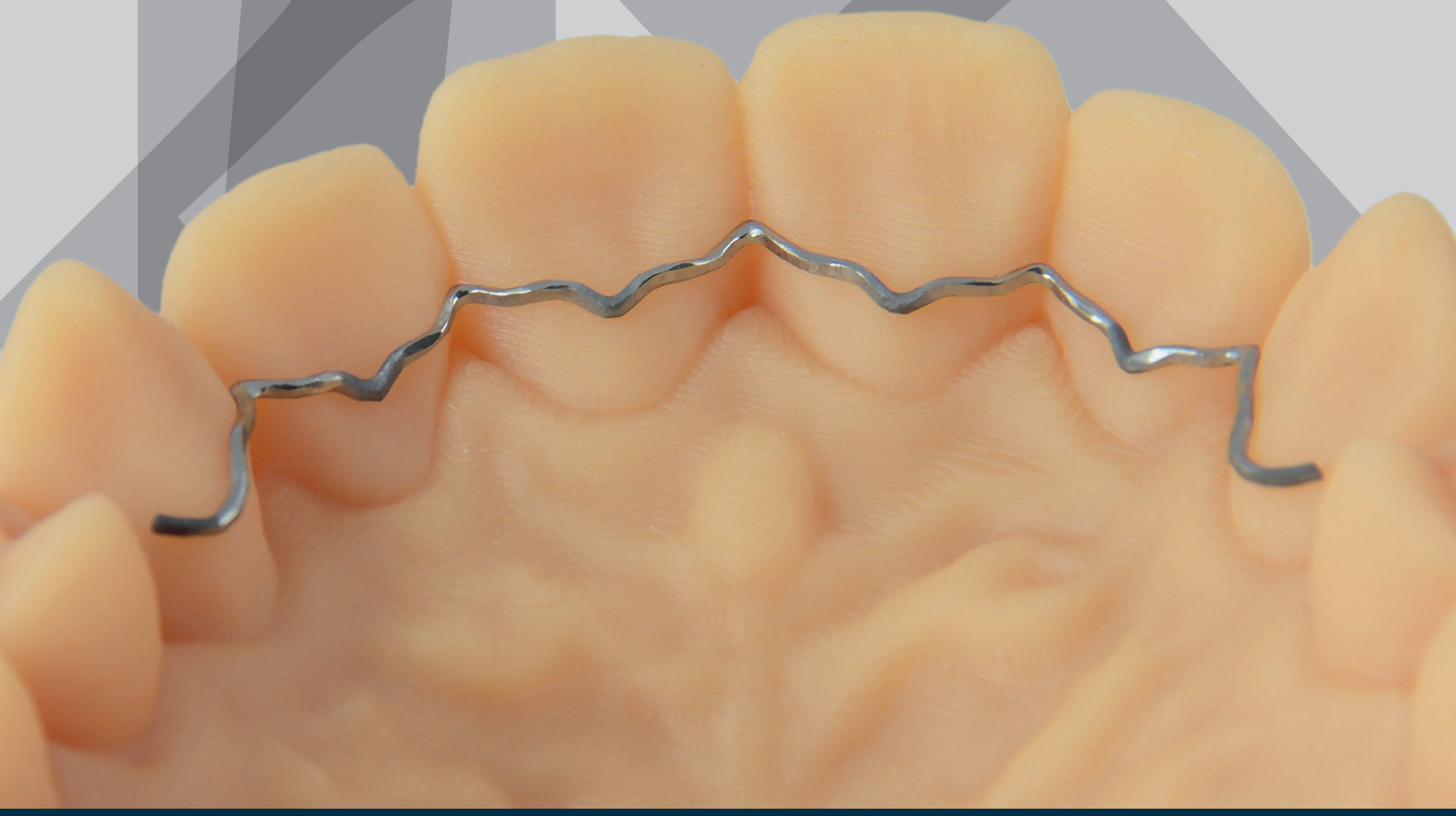
Field report

DENTAURUM



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KEYWORDS
Retention, 3D retainer, CAD/CAM, digital orthodontics, field report

ABSTRACT
Whether tailor-made or off the rack makes not only a big difference where clothing is concerned, but also fixed retainers. A good retainer is delicate and fits closely to the contours of the teeth, thereby causing little discomfort to the patient whilst remaining bio-compatible and stable in the long-term. Conventional retainers have their limits, particularly in their design and individual fitting. The prime4me® RETAIN3R is fabricated individually in high precision with the help of state-of-the-art digital technologies. This report looks at retainers in general and at the planning, fabrication and fitting of the 3D retainer from Dentaurum in particular.

Introduction

Following completion of orthodontic treatment, the question arises as to whether fixed retention of the final result from treatment is necessary and to be recommended, or whether it is nothing more than an expensive gimmick. Losses in retention such as changes to position and torque in the anterior segment or even undesirable side effects like the X or twist effect – despite fixed retention – give reason to doubt the merits of such retainers. All orthodontists encounter further negative outcomes in their daily work, such as adhesive failures, in particular where Twist-Flex retainers are used, or even fractured retainers. Many scientific studies have looked at the advantages and disadvantages of fixed retention.[1-8] Fortunately, such failures are a rarity, but is there no way of completely avoiding them? It has not yet been clarified why a wire that is actually passive becomes active over a longer period of time. Several approaches to find an explanation are under discussion.[9,10] These cover the untwisting of individual strands in twisted wires, the mechanical deformation of wires due to masticatory forces or natural tooth movements, and an elastic bending of the wires. Retainer wires that do not fit exactly and where a build-up of tension occurs from the adhesive bonding – rendering the retainers active – are a further problem. For these reasons, we now refrain from inserting twisted wires in our dental practice and have decided to insert 2 point steel retainers in the mandible which have been formed exactly (Fig. 1). In general, we were happy with the results since they make hygiene in the anterior segment of the mandible easy, they stabilize the distance between the canines, and the incisors maintain their physiological flexibility.[11] On

Fig. 1 A retainer made from a bent wire cannot be fitted to follow the course of the teeth exactly, particularly in the inter-dental spaces.

Fig. 2 The retainer, cut from a NiTi sheet (MEMOTAIN®, CA-Digital), is delicate and lies exactly on the tooth surface in a sagittal and transverse direction, i.e. in two planes. The material does not allow for an expansion in the vertical direction, i.e. in a third plane.

Fig. 3 A milled retainer (prime4me® RETAIN3R, Dentaurum) fits on the tooth surface in all three spatial dimensions. Since the third plane can be included, these retainers can be adapted to a wide variety of spaces and requirements.

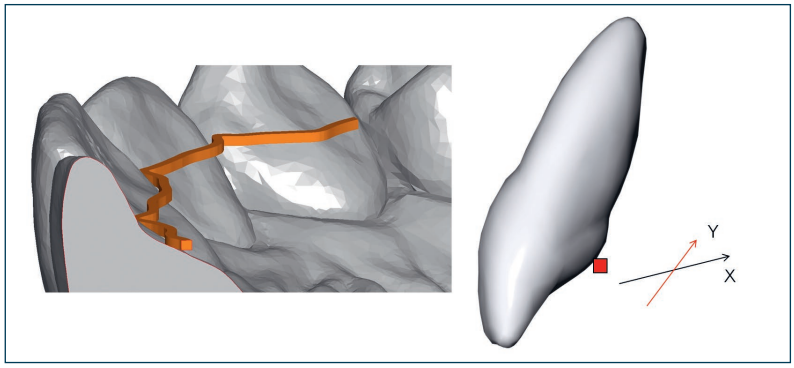

Fig. 4 An arch made from square wire that cannot be changed vertically can never lie fully on one or more inclined planes (palatal surfaces of the teeth). It can only be in contact with a corner of the profile of the inclined plane's surface. There is therefore always an empty space in a triangular form that depends on the angle between the square wire and the tooth surface.

the other hand, the conventional 2 point retainer appears somewhat unsuitable for stabilizing the anterior segment in the maxilla because of the wide diameter of the wire and its passive retention character.[12,13] Consequently, we choose to use CAD-CAM retainers such as MEMOTAIN® (CA-Digital, Fig. 2) and prime4me® RETAIN3R (Dentaurum, Fig. 3) as a solution for retention in the anterior section of the maxilla. The retainers are fabricated using computerized systems and are each individual. Latest examinations indicate that they offer the best combination of accuracy of fit, hygiene, patient comfort, passivity and stability. By this, they also fulfill the increasing demands made by our patients.

Whilst the classic Twist-Flex and 2 point steel retainers are fitted manually onto a plaster model, it is possible to produce an exact model of the jaw by using state-of-the-art CAD/CAM procedures along with a 3D modeling software. It is possible to precisely place a digitally designed retainer onto this model, taking the tooth morphology and the spatial relationship to the opposing teeth into consideration. In principle, this was the basic idea behind the first CAD/CAM fabricated retainer – known as MEMOTAIN®.[14,15] The virtually designed retainer is cut by machine out of a 0.3 mm sheet of NiTi (Fig. 2). On the one hand, this method of fabrication results in a square profile (Fig. 4) with no twists or turns, thereby lying linear on the teeth, and on the other hand the design is lacking flexibility in two planes (X and Y plane). It is also not possible to make changes in a vertical direction without endangering the fit as a whole. Initially, the fit of this delicate retainer on the tooth surfaces and in the inter-dental spaces appears to be excellent in the sagittal and transverse direction. It should, however, not be forgotten that the palatal surfaces of the teeth are very uneven and form very different angles to the square wire. It is therefore not possible - due to the geometry of the teeth - that the square wire can lie absolutely flat on the teeth. In fact, only one edge is in contact with the tooth surface.

2D or 3D?

Since 2015, we have mainly been using MEMOTAIN® retainers for the maxilla, and many of our patients were happy with this product. There were, however, situations where we would have liked to have expanded the exact fit to the vertical dimension. In the case of crowding, for example, it may be necessary to vary the incisal-cervical position (z-axis) of individual or all teeth because of antagonistic contacts.

The prime4me® RETAIN3R (Fig. 3) offers the three-dimensional retainer contour we required, in particular where space is an issue. As early as the planning phase, it is possible to identify the space available and take this into consideration in the design phase thanks to three-dimensional digital models and the possibility to view individual sections and the relation between maxilla and mandible sequentially. The prime4me® RETAIN3R is produced using an innovative process which enables the third dimension (vertical plane) to be expanded. A further advantage of the prime4me® RETAIN3R is the half-round profile with a diameter of 0.5 mm. The freedom to design the retainer in three dimensions means that it perfectly matches the contour of the teeth (Fig. 5).

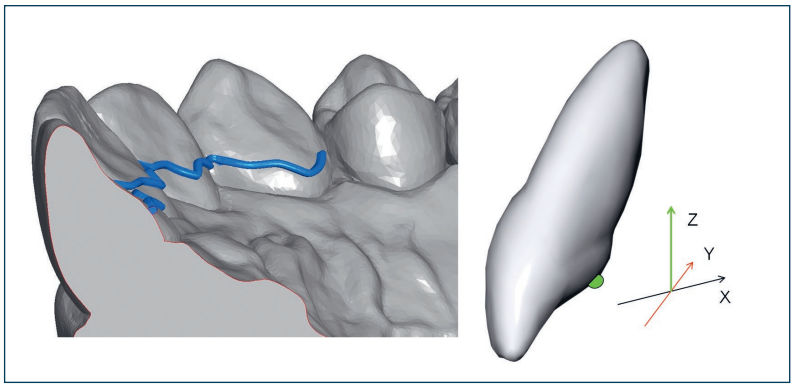

Fig. 5 A half-round profile that can be varied vertically always lies fully on the tooth's surface, even in the case of several inclined planes (palatal surfaces of the teeth). This is a prerequisite to physically include all anterior teeth.

Retainer material

When producing a retainer, it is essential that the materials used are biocompatible, corrosion-resistant and inherently stable. It is an advantage of using the CAD/CAM method that the retainers are cut from a sheet or block using state-of-the-art technology. The material is thereby removed, but not deformed, thereby avoiding the build-up of tension. By comparison, the material for conventional wire retainers is not removed, but bent into shape, thereby causing deformation. Tensions in the material are created which may, under certain circumstances, be released at a later stage, leading to deformations and a change in the position of the teeth. Sharp bends in the wire may also later break.

2D retainers are produced from a pseudo-elastic nickel titanium alloy. Their strong point is that the teeth are still able, to a great extent, to move independently.[15] Retainers must keep a balance between holding the teeth in position, whilst giving them the freedom to maintain their physiological inherent desire to move. This is also better attained with a titanium alloy than with materials based on CoCr. There is no finite conclusion on the extent to which inherent tooth movement causes retainers made of NiTi alloys to break, analogous to breakages in NiTi wires caused by strong bending movements.

Pure titanium is a soft and tough material, offering too little resistance in small dimensions to fulfill the task of a retainer. The prime4me® RETAIN3R is therefore made of the alloy Ti6A4IV (also known as titanium grade 5). This gives scope for a higher mechanical load capacity. Standard dimensions for a 3D retainer are 0.5 mm or, if requested, approx. 0.43 mm. The prime4me® RETAIN3R is very stable, despite the small diameter and can withstand more than 1,000,000 million chewing cycles.[16,17]

Added to this, titanium grade 5 is highly biocompatible, making it a good alternative for patients

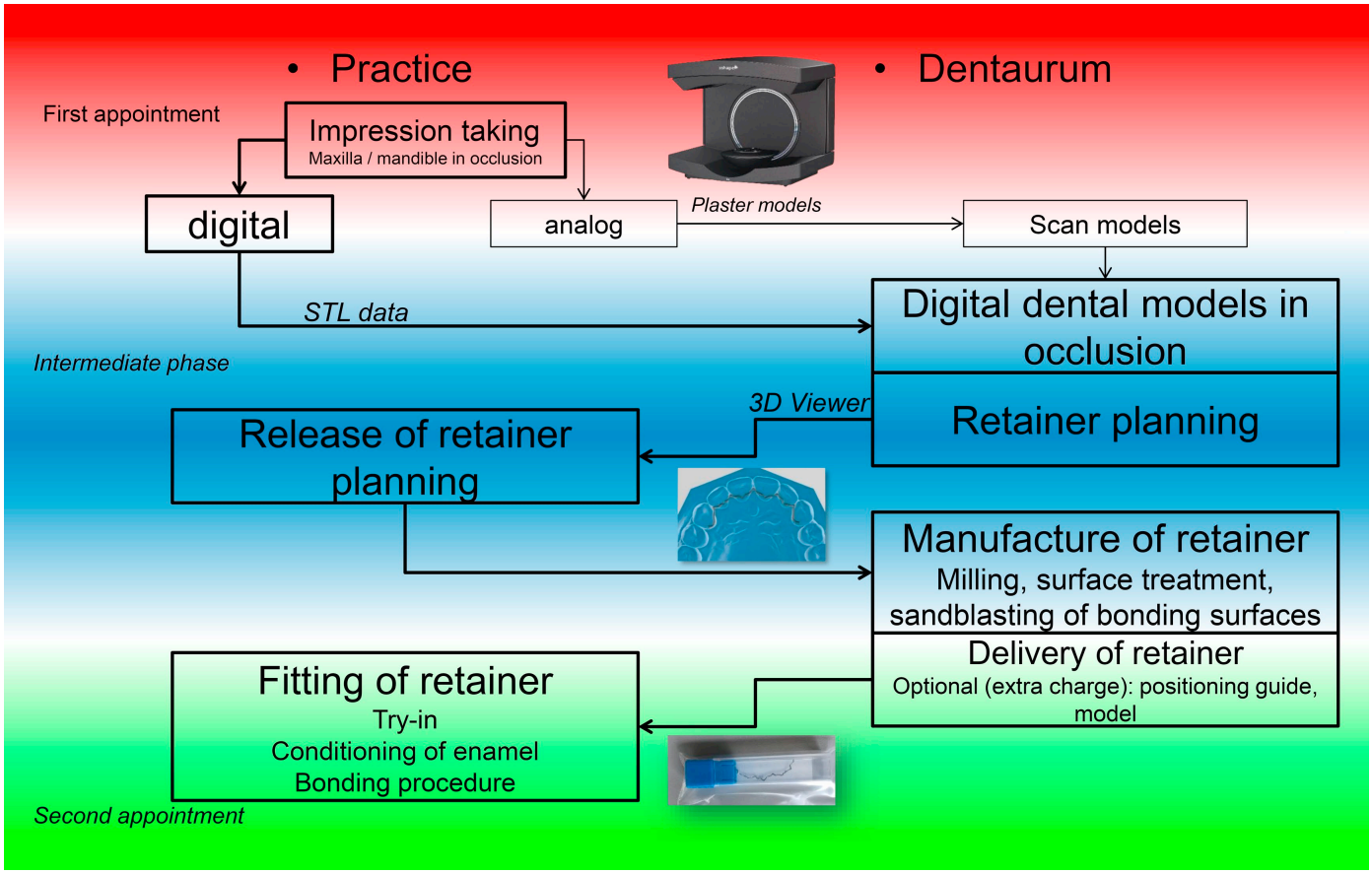

Fig. 6 Overview of the sequence of the individual process steps for using CAD/CAM manufactured retainers

with a nickel allergy. The titanium alloys also have no ferromagnetic properties in comparison to conventional steel retainers, so do not create artefacts during MRI examinations.[18]

Process steps

The following outlines the steps required from planning to the fitting of the prime4me® RETAIN3R (Fig. 6).

Impression taking

Every orthodontic appliance that is produced indirectly begins with an impression taken either digitally with an intra-oral scanner or by using an alginate impression and the resulting model which is created either digitally or in an analogous manner. It takes up to nine working days following approval from the orthodontist to produce a prime4me® RETAIN3R. The digital impression is taken about 2–3 weeks before the brackets are expected to be removed. This is to ensure that the teeth do not change position in the time between taking the impression and fitting the retainer.

It is sufficient to only take an impression of the mandible for a lingual retainer in the mandible. However, if a retainer is required for the maxilla, it is absolutely necessary to scan or take an impression of both the maxilla and the mandible and also to take a bite registration to show

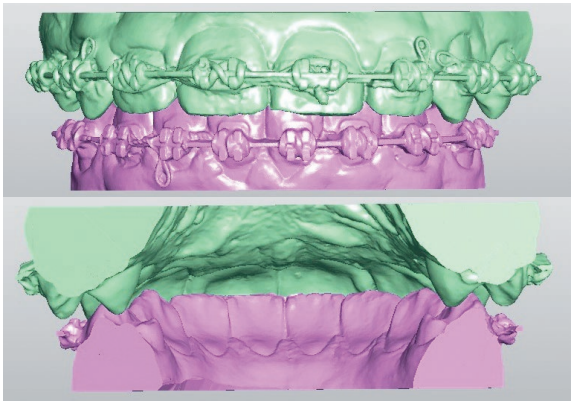

Fig. 7 The prime4me® RETAIN3R plan is made on the basis of the STL data of the maxilla and mandible in occlusion.

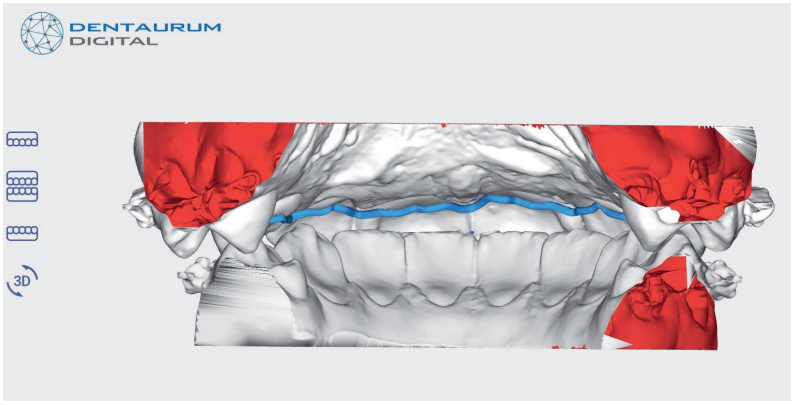

Fig. 8 Approval for the retainer plan is given on the basis of a three-dimensional image. The retainer can be viewed from all sides by moving the mouse. Individual elements – retainer, jaw – can be hidden or shown and highlighted in different colors for better visibility (see menu on the left and right-hand side).

the occlusion. The STL data from the impression scan (Fig. 7) are sent to Dentaurum when placing the order. If an intra-oral or model scanner is not available, it is possible to send the plaster model and the wax bite to Dentaurum who will then digitize the models.

Planning

An order is created via Dentaurum ,s home page (https://digital.dentaurum.de) to initiate production of the prime4me® RETAIN3R and a retainer with the required expansion is selected for the maxilla and mandible. It is also possible to store information on the course, the expansion and the dimensions of the retainer. There are almost no limits to the three-dimensional design of the prime4me® RETAIN3R as it is milled from a block of material. The next step is to upload the STL file generated from the 3D models. Plaster models are sent by post to Dentaurum.

The retainer is planned on the basis of the order information. The dental practice receives the planning information in electronic form at the most two working days later (Fig. 8). It is possible to view the retainer exactly from all sides and in all critical areas thanks to the possibility to rotate the image and blend individual elements in or out, or show them in different colors. If the planned retainer meets expectations, the orthodontist can approve the design. If changes are requested, the design is revised and sent again for approval.

Production

Once the design has been approved, the data is prepared and the retainer is milled from a block of rematitan® (Dentaurum) using a 5 axis milling machine (Fig. 9). In the final stage of production, the potential bonding areas are roughened by sandblasting (Fig. 10 and Fig. 3). This improves the connection between the retainer and the adhesive. The rest of the retainer‘s surface is very smooth which hinders the build-up of plaque.[19] Nine days after approval at the very latest, the retainer is securely packed and sent to the dental practice (Fig. 11).

There are often discussions on the necessity of a transfer jig to fit the retainer. Studies from the study group Wolf et. al., as yet unpublished, showed that there was a high correlation in all three spatial planes between the positioning accuracy of the inserted prime4me® RETAIN3R and the planned retainer; there were, however, slight deviations in the vertical dimension. This is

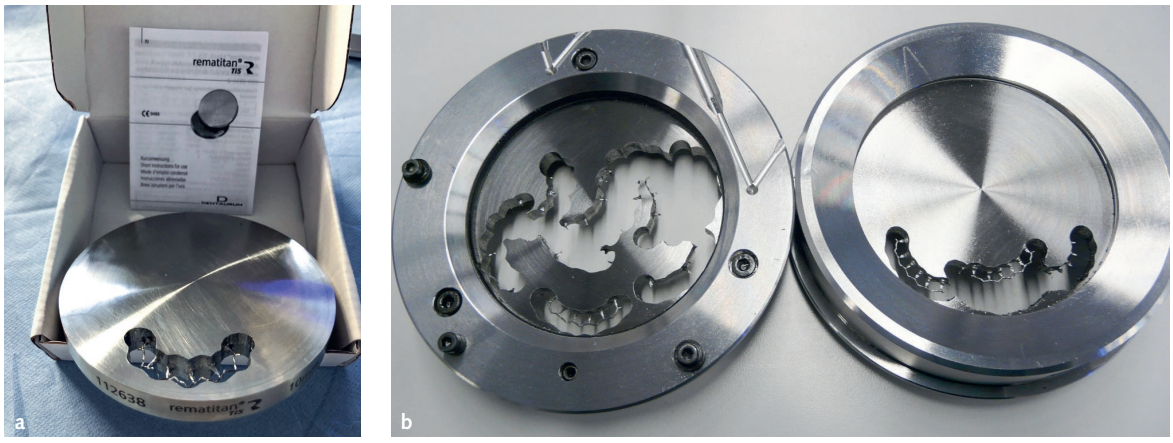

Fig. 9a and b The prime4me® RETAIN3R are made of rematitan® (Dentaurum). Several retainers can be milled from one blank.

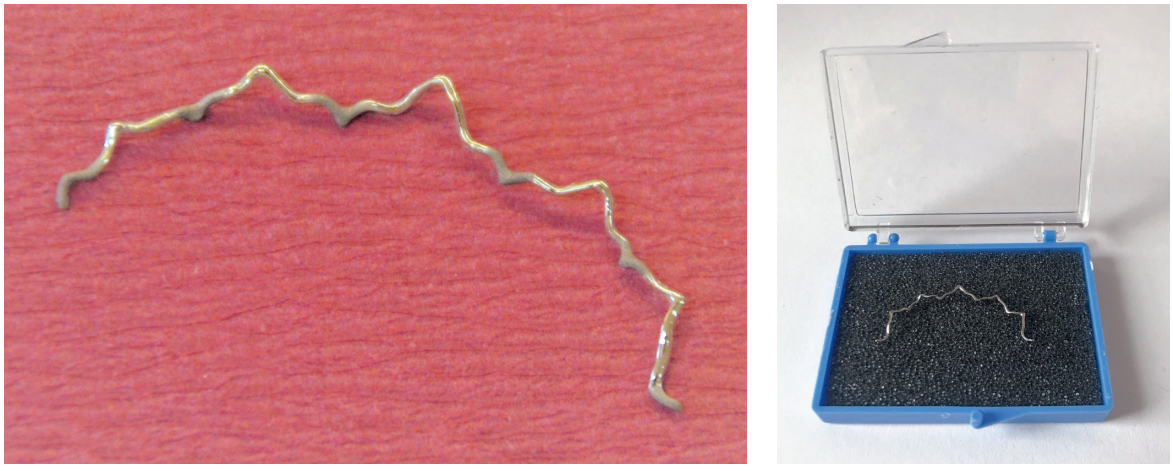

Fig. 10 The potential bonding areas on the retainer are roughened by sandblasting to bond better to the adhesive.

Fig. 11 Nine days after approval at the latest, the retainer is securely packed and sent to the dental practice.

the reason for the discussions on improving positioning by using transfer jigs. To date, no such jigs are available from the manufacturer. Dentaurum will offer this service in the future for the prime4me® RETAIN3R.

Fitting

Once the multi-bracket appliance has been removed and the teeth polished with a fluoride-free polishing paste (Omni clean and polish repair, OmniDent), the fitting of the prime4me® RETAIN3Rcan begin (Fig. 12). First, the positioning of the retainer is checked by temporarily fixing 5 threads (Fig. 13). Since the fit is so accurate, there is only one position for the retainer on the teeth. Note any premature contact of the antagonists in the final occlusal position.

An OptraGate® (Ivoclar Vivadent) is used for the next steps. This helps to keep the area of work dry and clearly in view. The oral bonding surfaces on the teeth involved are thoroughly sandblasted with aluminum oxide (50 µm, Airsonic® Alux-Oxyd, Hager Werken, Germany), the surfaces of the teeth are conditioned with 37% phosphoric acid (smile Etch, smiledental, Germany) which is thoroughly rinsed off after 60 seconds (Fig. 14). After the surface of the teeth has been dried, a chalk-like discoloration of the enamel surface shows that the conditioning was successful (Fig. 15). Cotton wool rolls should be used to keep the areas to be bonded dry. Apply a thin

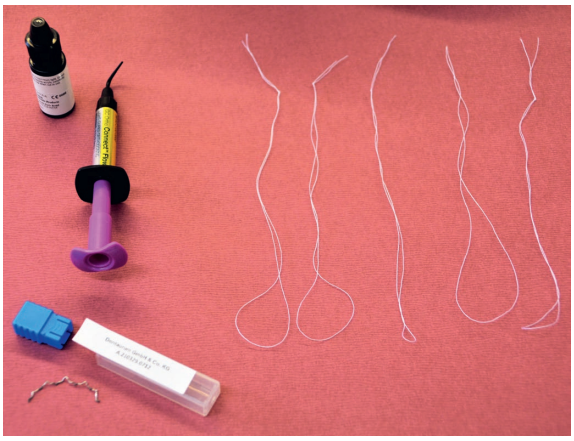

Fig. 12 To fit the prime4me® RETAIN3R, threads, 37% phosphoric acid, bonding and adhesive agents are required.

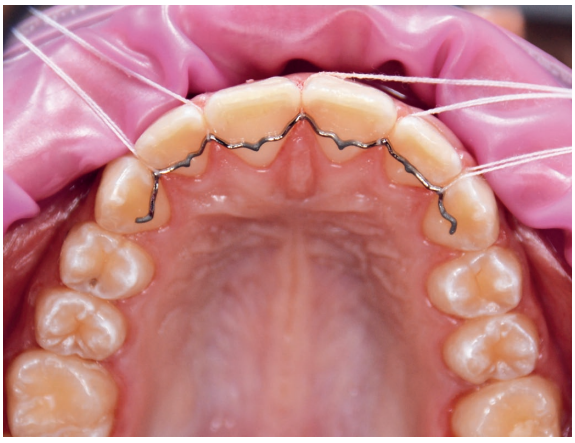

Fig. 13 The retainer is fixed to the teeth for the try-in and for bonding with threads in all interdental spaces.

Fig. 14 Following etching, the areas to be bonded are rinsed thoroughly with water.

Fig. 15 Drying of the areas to be bonded

Fig. 16 Applying the bonding agent

Fig. 17 The threads are used to pull the retainer into the correct position.

layer of bonding material (Transbond XT, 3M, Germany) using an applicator (Fig. 16). As for the try-in, the retainer is pulled through the loops of the threads (Fig. 17) and brought into position by pulling the threads tight. The correct fit is given a final check before the adhesive is applied as required (Fig. 18).

A low viscosity adhesive (Ortho Connect Flow, GS Orthodontics or Transbond Supreme LV, 3M Unitek) is used for bonding. It is applied in a thin layer to the sand-blasted and prepared surfaces by slightly covering the retainer. Adhesive applied in a thin layer has no negative impact on the holding force of the retainer on the teeth. In-vitro tests showed that both thinner and thicker bonds held for more than a million chewing cycles.[16]

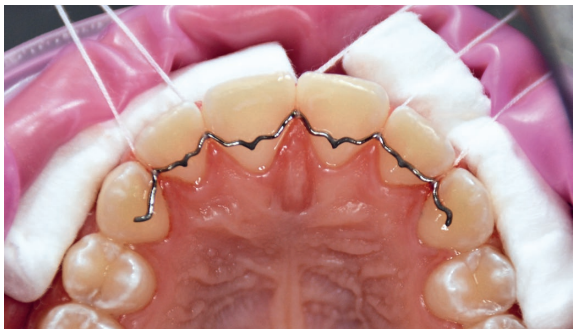

Fig. 18 The correct fit is checked once more before the adhesive is applied.

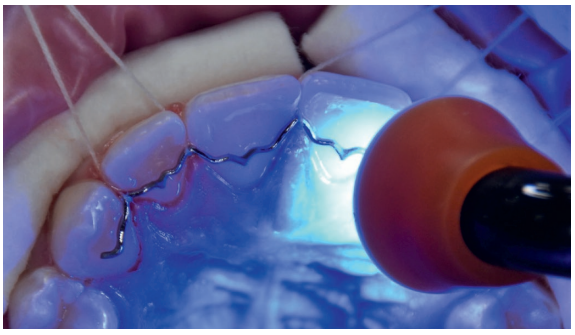

Fig. 19 Curing the adhesive.

Fig. 20 The threads are cut and removed with Weingart pliers after the adhesive has cured.

Fig. 21 A probe is used to check that the transition from the adhesive to the tooth is smooth.

Fig. 22 Occlusion foil is used to monitor premature contacts.

Fig. 23 There must be no occlusal contact points on the retainer or the bonding points.

The adhesive is first applied to the teeth at each end of the retainer, a probe is used to smoothen the area between tooth and adhesive, and the adhesive is then light-cured. This is then repeated for the remaining teeth (Fig. 19).

The threads are removed after the adhesive has cured. (Abb. 20). A probe is used to check that the transition from the adhesive points to the teeth is smooth and that there are no gaps (Fig. 21). Standard procedure is to then check occlusion using an occlusal foil (Fig 22). If the occlusal contact areas are on the teeth and not in the area of the retainer, the planning evidently corresponds to reality (Fig. 23).

Customized product for all sizes and every occasion

Retainers that are manufactured conventionally or two-dimensionally always present a compromise where the fit, comfort and intended purpose are concerned. Three-dimensional customized designs, however, give an exact fit for the intended purpose. The diverse design possibilities for prime4me® RETAIN3R enable several teeth to be reliably held together in many clinical situations. This is demonstrated by the following examples.

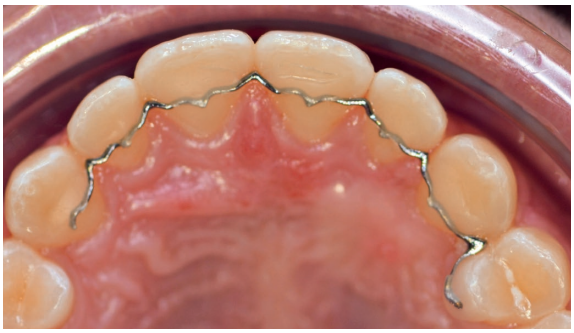

Fig. 24 By expanding to the bicuspid, the retainer stabilizes a previously displaced, exposed and aligned cuspid.

Fig. 25 A flat prime4me® RETAIN3R running closely to the cervical area stabilizes the loose anterior teeth without disturbing occlusion. Photo by courtesy of Drs. Elisabeth and Martin Orleth (Nürtingen, Germany).

Fig. 26 The retainer stabilizes the position of tooth 11. Photo by courtesy of Drs. Elisabeth and Martin Orleth (Nürtingen, Germany).

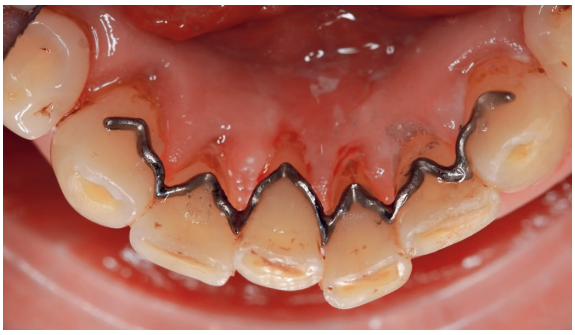

Fig. 27 The first lower anterior teeth were particularly loose. A retainer was used as a splint. Photo by courtesy of Prof. Paul-Georg Jost-Brinkmann (Berlin, Germany).

When a retained cuspid has been exposed, the retainer can be used to stabilize the tooth in the dental arch, even after the active treatment has ended. For this reason the retainer includes also the first bicuspid (Fig. 24). If deemed necessary, the retainer could also be extended to include the second bicuspid.

Alongside its use in orthodontic applications, the 3D retainer also has an interesting additional use. It can, for example, be used as a splint retainer for periodontally damaged teeth. There are differing views on this type of splinting. On the one hand, the damaged teeth should be blocked together; on the other hand, if they are held too rigidly in place, the effect on the tooth's own mobility is restricted. The prime4me® RETAIN3R is maybe a good compromise for such splinting. To date, however, there are no long-term data available. From a technical point of view there are many interesting solutions as far as the design is concerned. Several case studies serve to illustrate the broad field of application of the prime4me® RETAIN3R in this indication area.

Mobile anterior teeth can be splinted in the maxilla (Fig. 25 and Fig. 26) and in the mandible (Fig. 27). The freedom in designing the retainer means that the splint can be adapted to a large variety of situations. In the last case, tooth 31 moved away from the group of teeth after approx. six months and had to be extracted. The ensuing gap was closed by fixing a prosthetic tooth to the retainer. This was still found to be in place after a period of observation spanning more than one year (Fig. 29).

It is not imperative that a retainer used to splint periodontally damaged teeth is fitted on the oral surfaces. Since there are almost no limits to the design, the vestibular surfaces can also be used (Fig. 30). Technically, there are no limits on the number of teeth which can be covered by the splint. As the example in Fig 30 shows, almost the whole dental arch can be included. In such a case, however, it is important to consider the direction of insertion so that the retainer can be fitted.

Fig. 28 The patient from Fig. 27 lost tooth 31. A prosthetic tooth was attached to the retainer. This image was taken 16 months after repair. Photo by courtesy of dentist Larissa Strieder (dental practice Annett Urbank, Basdorf, Germany).

Fig. 29 A retainer can also be made as a labial periodontal splint.

Fig. 30 A retainer used as a splint can also cover the whole dental arch. In such a case, however, it is important to consider the direction of insertion so that this complex construction can be fitted. Photo by courtesy of MDT Keith Gemperling (Trident Zahntechnik GmbH, Leipzig, Germany)

Conclusions

In the light of the above, a CAD/CAM manufactured prime4me® RETAIN3R is an excellent solution as a permanent form of retention due to its three-dimensional design, good functionality and high level of patient comfort. Why should a good orthodontic result, sometimes achieved by great effort, be endangered by a lack of sufficient retention? The prime4me® RETAIN3R can therefore be highly recommended to patients thanks to the freedom in design and the exact fit on the oral surfaces of the teeth.

Bibliography

1. Wolf M. Post-treatment changes in permanent retention. J Orofac Orthop 2016;77: 446-453.
2. Shaughnessy TG. Inadvertent tooth movement with fixed lingual retainers. Am J Orthod Dentofacial Orthop 2016;149: 277-286.
3. Kravitz ND. Memotain: A CAD/CAM nickel-titanium lingual retainer. Am J Orthod Dentofacial Orthop 2017;151: 812-815.
4. Katsaros C. Unexpected complications of bonded mandibular lingual retainers. Am J Orthod Dentofacial Orthop 2007;132: 838-841.
5. Pazera P. Severe complication of a bonded mandibular lingual retainer. Am J Orthod Dentofacial Orthop 2012;142: 406-409.
6. Kocher KE. Survival of maxillary and mandibular bonded retainers 10 to 15 years after orthodontic treatment: a retrospective observational study. Prog Orthod 2019; 20:28.
7. Butler J. Orthodontic bonded retainers. Journal of the Irish Dental Association 2005;51: 29-32.
8. Aycan M. Comparison of the different retention appliances produced using CAD/CAM and conventional methods and different surface roughening methods. Lasers in medical science 2019;34: 287-296.
9. Padmos JaD. Epidemiologic study of orthodontic retention procedures. Am J Orthod Dentofacial Orthop 2018;153: 496-504.
10. Kucera J. Unexpected complications associated with mandibular fixed retainers: A retrospective study. Am J Orthod Dentofacial Orthop 2016;149: 202-211.
11. Artun J. A 3-year follow-up study of various types of orthodontic canine-to-canine retainers. Eur J Orthod 1997;19: 501-509.
12. Schütz-Fransson U. Twelve-year follow-up of mandibular incisor stability: Comparison between two bonded lingual orthodontic retainers. Angle Orthod 2017;87: 200-208.
13. Störmann I. Prospektive randomisierte Studie zur Untersuchung von unterschiedlichen Retainertypen. J Orofac Orthop 2002;63:42-50.
14. Schumacher HB: Retainer sowie Verfahren zu dessen Herstellung. 2014: Patent DE 10 2013 204 359 A1 2014.09.18
15. Schumacher P. CAD/CAM-gefertigte Lingualretainer aus Nitinol. KN 2015;13: 1+4-7.
16. Jasser N. Langzeit Dauerbelastungsvergleich von gefrästen Titan-Retainern mit breiter oder schmaler Klebestelle Danube Private University Krems 2019, Master of Science Kieferorthopädie“ (MSc)
17. Wieland R. Langzeit-Kausimulationsmaschine für das Testen von 3D-CAD/CAM-Retainern im Vergleich zu konventionellen Retainern. Danube Private University Krems 2019, Master of Science Kieferorthopädie“ (MSc)
18. Roser C. Evaluation of magnetic resonance imaging artifacts caused by fixed orthodontic CAD/CAM retainers-an in vitro study. Clin Oral Investig 2021;25: 1423-1431.
19. Knaup I. Potential impact of lingual retainers on oral health: comparison between conventional twistflex retainers and CAD/CAM fabricated nitinol retainers : A clinical in vitro and in vivo investigation. J Orofac Orthop 2019;80: 88-96.

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