Combination dentures: an indication-specific material mix in the digital workflow

VITA

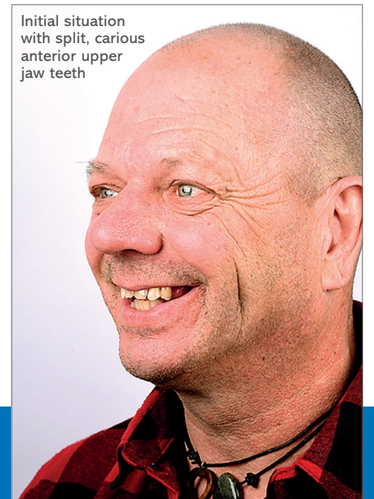
By **Arbnor Saraci**, **Lukas Wichnalek** and **Norbert Wichnalek**

Arbnor Saraci

Lukas Wichnalek

Norbert Wichnalek

Digitization now provides completely new material options for dentists and labs that are metal-free and offer the right choice for every indication. Where restorations used to be made with wax-ups, they are now increasingly designed on a computer. A digital laboratory is full of grinding, milling and printing noises. Where metal frameworks used to be veneered, feldspar ceramics, glass ceramics, zirconia, high-performance polymers and hybrid materials are now used. Less and less pouring is done. The following case study demonstrates the interaction that is already possible today in a commercial laboratory between digital diagnostics, design software, hardware and CAD/CAM materials. Using a virtual patient as a basis, a combined fixed and removable prosthetic piece is created from completely different material components that are predestined for the respective area of application.



Initial situation with split, carious anterior upper jaw teeth

CASE STUDY:

A 58-year-old patient came to the practice because he had been dissatisfied with the functional and aesthetic condition of his upper jaw for quite some time. With the exception of tooth 14, all the premolars and molars in the posterior region had been lost over time. Anterior teeth 11 and 21 showed fractures in the incisal region. Secondary caries had been diagnosed in teeth 21 and 23. The patient had several desires for the new restoration: The situation should be functionally stabilized and age-appropriate aesthetically in the front tooth area. The restoration should be as metal-free as possible, and due to time constraints, should be carried out in as few sessions as possible. An implantation was out of the question for the patient because of difficult anatomical conditions that involved very little bone availability in some places, and would entail complex surgical procedures. After a detailed consultation, he decided on a combined fixed and removable denture. This was to be manufactured in a digital workflow in order to be able to choose the right mix of materials and reduce the treatment time to a minimum, despite the prosthetic complexity.

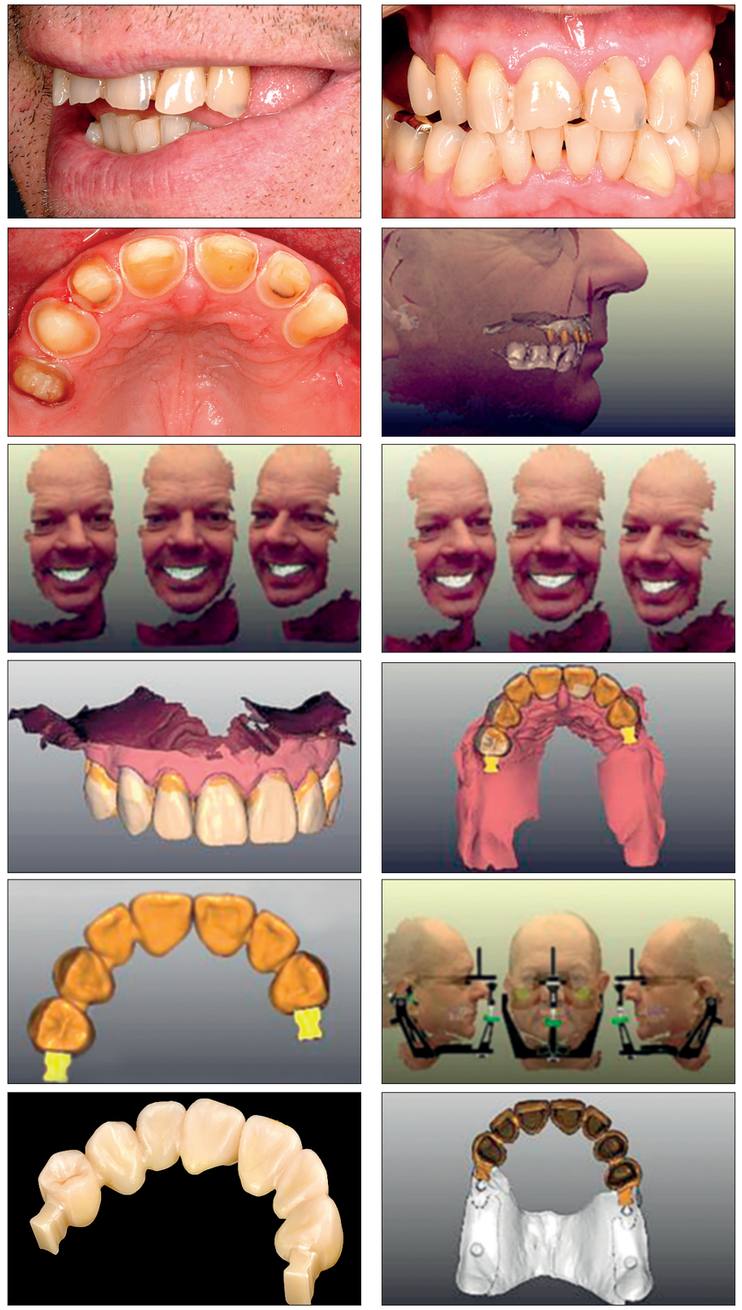
Zirconia

The remaining teeth in the upper jaw were to be supported with splinted crowns from 11 to 14 and 21 to 23, with integrated extra-coronal attachments in distal direction. The goal was to restore the aesthetics and to ensure sufficient stability for anchoring the removable dentures. The multichromatic and super-translucent zirconia VITA YZ ST was chosen, which offers a natural-looking and stable framework for partially veneered restorations. The zirconia material is suitable for bridges with up to 14 units in the anterior and posterior region, and it offers a consistently high strength of 1200 MPa, in addition to aesthetic advantages. The super-translucent blanks have to be dry milled in order to obtain optimal light-optical properties. The two frameworks were to be constructed with only a slight vestibular reduction in order to make a patient-friendly, minimal surface finishing with the low-fusing, leucite-reinforced glass-ceramic VITA LUMEX AC (both materials VITA Zahnfabrik, Bad Säckingen, Germany). The functional areas consistently remained purely monolithic for sustained clinical long-term stability. The zirconia system VITA YZ offers precise shade fidelity to the VITA shade standards. In this case, the tooth shade of the natural teeth was determined to be A3 using the VITA classical A1-D4 shade guide, and the multichromatic blank VITA YZ ST A3 was selected as true-to-shade. The determined basic tooth shade is reproduced reliably by the selected blank, while the integrated shade gradient already monolithically ensures a natural appearance. After the individualization with veneering ceramic, the final characterization and glazing was to be carried out with the VITA AKZENT Plus stain system.

High-performance polymer PEEK

The framework of the removable partial denture was to be made from a high-performance polymer blank from the PEEK family, as the patient wanted the restoration to be as metal-free as possible. Due to its low weight, the material offers high wearing comfort and is chemically inert, which means that the highest possible biocompatibility can be expected. The low flexural modulus could be an advantage in compensating for chewing forces.

However, in our experience, a number of factors must also be considered with such a framework construction. The usual metal construction cannot simply be copied when high-performance polymers are used. In order to achieve the minimum layer thicknesses of 0.6 to 0.7 mm, almost three times more space is required than for metal. The patient must also be informed that constructions made of PEEK or PEKK, like all others made of acrylic and high-performance polymers, tend to absorb more or less water, which can result in an unpleasant odor. Plaque susceptibility must also be considered. In the course of clinical use with countless chewing processes, even the smoothest PEEK surface develops micro-retentive grooves over the long term, which subsequently promotes plaque accumulation. Each new high-gloss polish is in turn associated with a certain loss of substance. In this case, a large part of the PEEK surface was in the palate area, which is subject to constant natural cleaning through tongue activity. Nevertheless, the patient was also informed about this fact with regard to his own oral hygiene at home. In this case, the freedom from metal and the wearing comfort outweighed these disadvantages in the patient's personal decision-



FROM TOP ROW (LEFT TO RIGHT): Except for one premolar in the first quadrant, the complete support zone was missing in the maxillary posterior region; The intraoral situation in the habitual terminal occlusion with damaged teeth 11 and 21; Status following full crown preparation of all teeth in the upper jaw; Prepared stumps and opposing dentition were scanned intraorally and integrated into the facial scan; The initial situation matched with the facial scan was used as the starting point for the construction of the crown blocks; In collaboration with the patient, a virtual mock-up was created; Based on the virtual mock-up, both splinted crown units could be constructed; The splinted crown units constructed with extra-coronal attachments in the occlusal view; In the vestibular part of the crowns, non-functioning windows were integrated for individualization; The support zone in the posterior tooth area could also be constructed based on the information from the facial scan; Both splinted crown units with extra-coronal attachments made of the zirconia VITA YZ ST Multicolor; The denture base with matching attachment matrices was constructed out of a high-performance polymer of the PEEK family.

making process.

Precisely fitting recesses for the TK1 friction element were planned in the construction of the framework in order to be able to continuously adjust a sufficient hold on the extra-coronal attachment of the splinted crown units, and to provide a handling that was as patient-friendly as possible. An integrated bar was to be constructed in the posterior region in order to ensure a secure fit of the splinted posterior region in the future. A lifelike finish with the flowable and light-curing veneering composite VITA VM LC flow was planned for the denture saddles. The gingival anatomy was not to be reproduced in an exaggerated manner, and stippling was to be consistently avoided in order to prevent accumulations and deposits, and to ensure a pleasant feeling in the mouth.

Composite

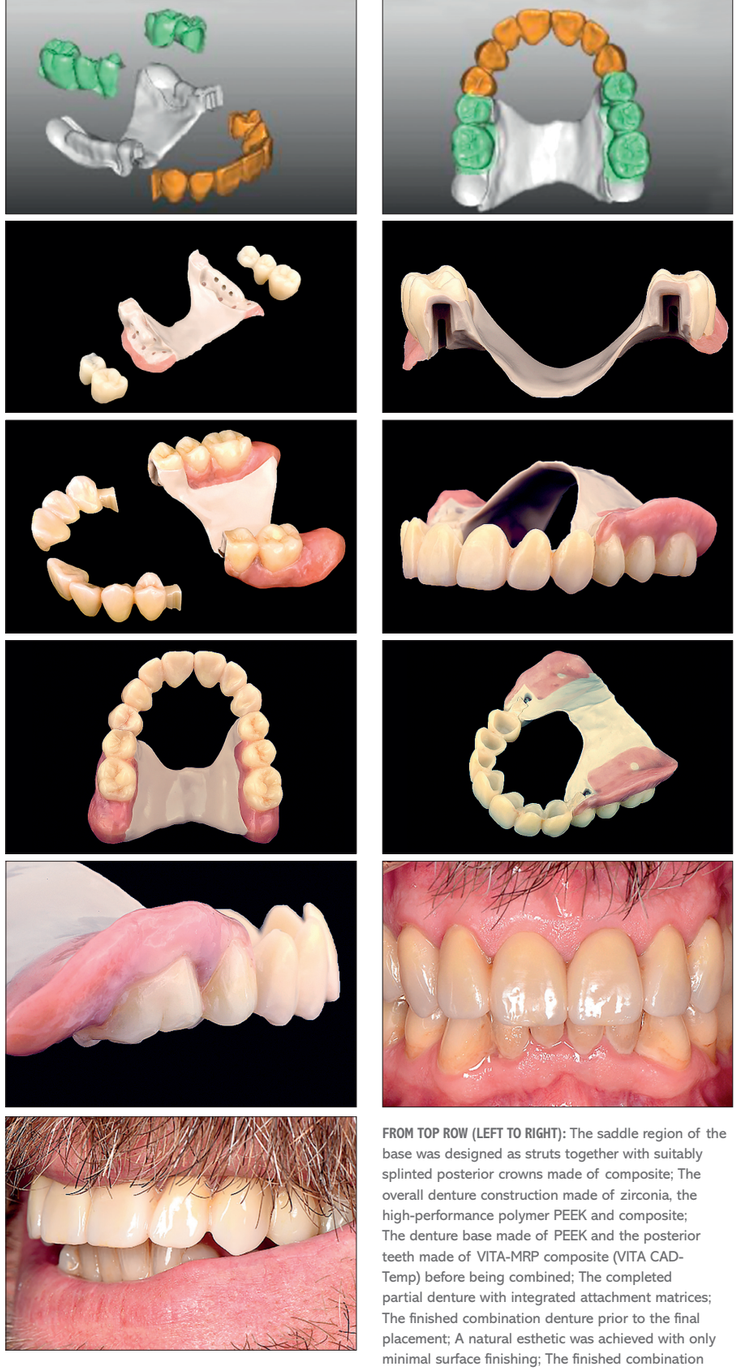
The long-term provisional and multichromatic CAD/CAM composite VITA CAD-Temp was selected for the posterior region, analogous to the prefabricated teeth. The material consists of the Microfiller Reinforced Polymer Matrix (MRP) from which the VITA prefabricated teeth are also made. This is a high-molecular and highly cross-linked acrylate polymer with polymerized micro-fillers, which is responsible for the outstanding abrasion resistance of VITA prefabricated teeth. The missing premolars and molars were to be splinted and constructed on the lumen side to match the denture saddles and milled out of a blank. The incorporation of central cylindrical zirconia inlays was planned in the first molars inside the crown. They were to function as central stops over the long-term clinical course. The vertical height was to be stabilized, if necessary, and functional freedom was to be provided in the composite material for eccentric abrasive processes at the same time.

The virtual patient

For a virtual work basis, several digital data sets had to be created and combined with each other. A facial scan (Face Hunter, Zirkonzahn, Gais, South Tyrol, Italy), an intraoral scan before and after the preparation and in habitual occlusion (Medit i500, MEDIT, Seoul, South Korea), was carried out. By virtually defining the reference points from the face scan and the habitual occlusion, the two splinted crown units with extra-coronal attachments and the missing support zones could be constructed. An individual tray was designed and additively manufactured for the overall construction in order to mould the tooth stumps in the upper jaw.

Analog control option

For controlled assembly and harmonious individualization of the prosthetic material components manufactured with CAD/CAM support, an analog control option was to be created on the basis of the virtual data. Models were created on the basis of impressions in the upper and lower jaw and digitized in the Medit T710 laboratory scanner (MEDIT, Seoul, South Korea). In the CAD software, the virtual models could be articulated in relation to the skull, based on the information from the face scan. The upper and lower jaw models were additively manufactured with integrated support pins for patient-appropriate centric positioning. Using the digital workflow, the die impressions of the upper jaw were subtractively transferred to the PlanePositioner (Zirkonzahn, Gais, South Tyrol, Italy). This made it possible to centrically articulate the upper jaw and then to articulate the lower jaw as well, with the help of the integrated model support pins. The virtual articulation was now also physically present.



FROM TOP ROW (LEFT TO RIGHT): The saddle region of the base was designed as struts together with suitably splinted posterior crowns made of composite; The overall denture construction made of zirconia, the high-performance polymer PEEK and composite; The denture base made of PEEK and the posterior teeth made of VITA-MRP composite (VITA CAD-Temp) before being combined; The completed partial denture with integrated attachment matrices; The finished combination denture prior to the final placement; A natural esthetic was achieved with only minimal surface finishing; The finished combination denture in the occlusal view; Matrix and patrix fit precisely into one another, thanks to the CAD/CAM-supported production; The saddle portions were subtly individualized, while care was taken with flat surfaces; The integrated combination denture in its habitual terminal occlusion; Shade effect, morphology and texture of the anterior maxillary region harmonized with the incisors in the lower jaw.

Clinical try-in

After the two splinted crown units with extra-coronal attachments made of multi-layered VITA YZ ST A3 were fabricated with CAD/CAM support, they were tried in clinically. In order to compensate for the divergences between the mechanical-static model situation and the biodynamic patient situation, the saddle portions and the tooth morphology were printed as a monoblock to match the extra-coronal attachments. These custom-fit bite templates were used for subsequent registration on the patient, which was then transferred to the virtual and analog articulator for completion.

Plasma conditioning and fixation

Based on the patient-appropriate new articulation, the framework of the partial denture was constructed from the high-performance polymer PEEK, and the posterior teeth were constructed from the CAD/CAM composite VITA CAD-Temp as a crown block. Both were then subtractively manufactured and finished in the digital workflow. After the two saddles had been made with a gum-colored cold-curing polymer resin, the crown lumen and the denture base were conditioned on the adhesive surfaces with low-pressure plasma (DENTAPLAS PC, Diener Plasma, Ebhausen, Germany). Both denture components were then adhesively bonded to one another using the tooth-colored VITA VM CC cold-curing polymer resin. After the final individualization of the denture saddle with VITA VM LC flow, the combination denture was completely cleaned with plasma, welded in, sent to the practice and integrated there.

Tailored combination of materials

Today, the digital workflow makes it possible to find the right material for every indication and every patient request. In this case, it was possible to create a tailor-made combination denture from three different CAD/CAM materials on a digital diagnostic working basis. The crown blocks made of zirconia in the front provide stability for the overall construction, and offer basic aesthetics with the integrated shade gradient. The framework of the partial denture made of PEEK was light, offered the greatest possible freedom from metal and was comfortable to wear. The composite crown blocks in the posterior region had the proven material properties of prefabricated teeth. Veneering and staining systems appropriate to the material are available for the minimal individualizations that enable efficient and individual surface finishing. The patient was completely satisfied with the quick result, the reduced treatment time and the aesthetic result.

The patient was absolutely satisfied with the function and aesthetics of his new restoration