Pro-Arch restoration with PEKK beam and monolithic zirconium oxide

Can we plan for success?

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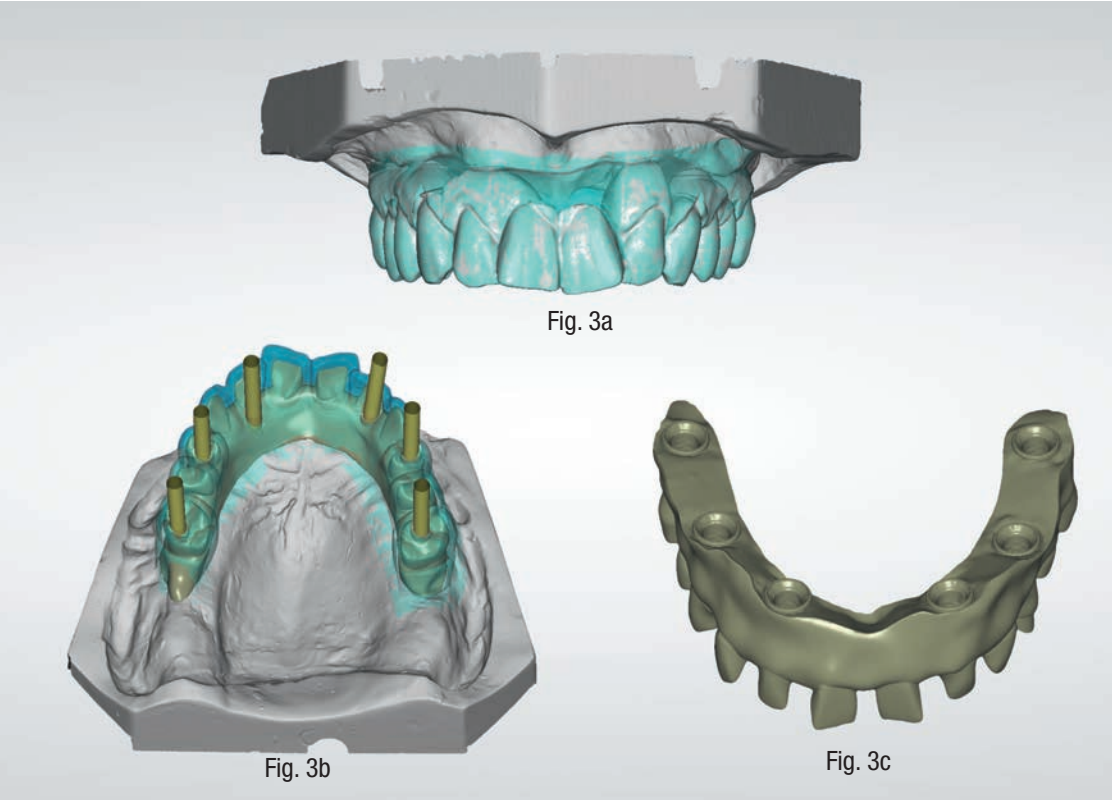
An advantage of CAD/CAM-assisted fabrication is the multiplicity of materials linked to it. A wide range of materials can be used in combination with the manual work phases. Economics satisfies the dental technician in the same way as the need for aesthetics and function. This article discusses the manufacture of a beam for an implant-supported circular bridge in PEKK Pekkton material. The teeth were milled from monolithic zirconium oxide, after which individual characterization was performed manually.

Fig. 1 — Six implants in an edentulous maxillary must be restored with a partially removable prosthesis (Pro-Arch)

Figs. 2a & 2b — The manually made set-up with pre-packaged teeth is prepared for a try-in in the mouth

Figs. 3a to 3c — The digitized set-up served as the basis for the construction of the beam (reduced crown shape and reduced gingiva)



Digital technologies change the world step by step. Traditional dental craft enterprises take advantage of this, ingeniously combining digital know-how with skill and craft techniques. In addition to accuracy and reproducibility, CAD/CAM technology offers the advantage of the multiplicity of materials. For the dental technician this also means knowledge! In particular, the field of scientific materials appears more important today than never. Modern dental technology rests on three pillars: craftsmanship, knowledge and service. These are combined with the passion for doing, creativity and affinity for digital technologies. In this combination is what appeals to dental technicians.

Recognizing perspectives

It's certainly not just dental technology that changes, but the whole environment. Modern society continuously demands more and more solutions. People demand much from themselves and from others when it comes to health, medical care and aesthetics. In this way, a dental prosthesis with its aesthetics, quality, function and longevity represents a great value.

Each day in life, the exercise of balancing the possibilities and concepts can only happen if we confront each other in a well-founded way with changes. But what about profitability?... Is it still okay? Can we be more economical?

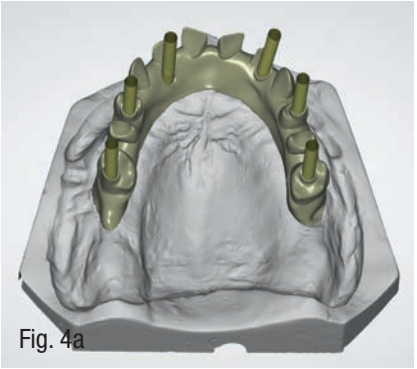


Fig. 4a

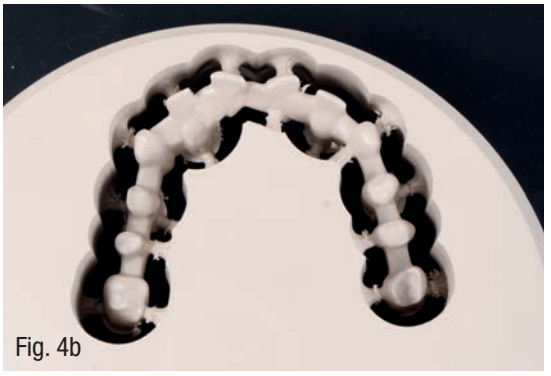


Fig. 4b

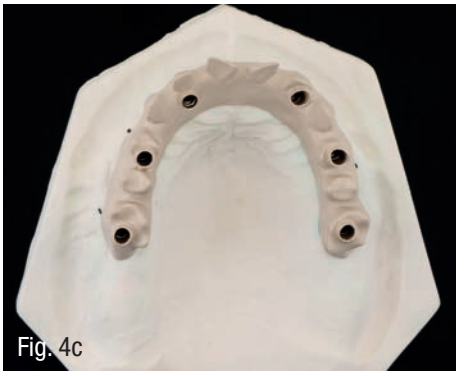


Fig. 4c

Figs. 4a to 4c — The structure was milled from a raw piece of PEEK (Pekkton ivory) and finished

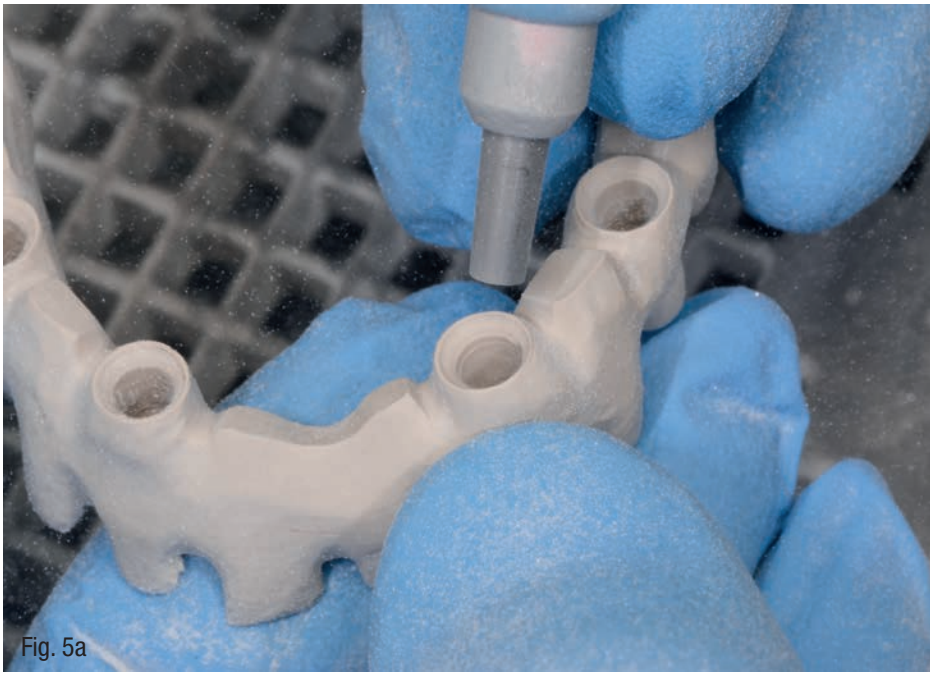


Fig. 5a


Fig. 5b


Fig. 5c

Figs. 5a to 5c — Conditioning of PEEK structure and titanium bases for adhesive cementation of components

Dental technicians are asked to critically analyze new technologies, to test their use in daily work and to verify the stages of processing on the basis of tested assumptions. Only in this way concepts that serve to optimize the daily work of the dental technician are born over time in a lasting way.

Communication: finding new ways

Total prosthesis and monolithic restoration digitization (dental and implant support) are currently the center of attention. At the same time, the classic sectors of fixed and removable prostheses are overlapped. Together, they must be defined as new processes. This requires communication. A dialogue drawn from the daily life of the authors in their laboratory makes it clear.

Dialogue

"Can we make an implanted-supported "bridge wrap around" without ready-made teeth in resin?"

Dominik Mader

"But I, as a ceramist would be already pleased. I could build it, mill it, characterize it and finalize it with the ingenious 3D paste CeraMotion One Touch!"

Dominik

"Yes, of course, this is possible. For example: an oxide bridge of integral zirconium. Hard as a stone and difficult to make!"

"Sounds nice, but did you think to the test in the mouth? What do you do when the position of the teeth or the determination of the intermaxillary relationships are not good? Then start from the anterior. This is not cheap. In addition, with integral zirconium oxide you are dependent on the system, and maybe you don't have the right milling machine."

Patrick

Master dental technician Patrick Zimmermann

"Hmm ... you're right. But at least we would not have abrasions like in resin teeth."

Dominik

"We should then exploit the advantages of titanium devata to be able to screw the work directly..."

Dominik

"It is true, but is it true that the prostheses don't abrade at all? Natural teeth are subject to abrasion."

Patrick

"... Yes, or better yet, we could use a polymer for high performance, which is suitable for this indication. Resin as a shock absorber for muscle chewers and..."

Patrick

"It's complicated. In fact, you should mix the two versions together. The flexibility of a resin with the solidity of oxide zirconium."

Dominik

"... posterior teeth in zirconium oxide to ensure longevity of work."

Dominik

"Let's try it.."

Patrick

"Aesthetics thanks to the steps of usual work, profitability thanks to the use of its infrastructure..."

Patrick

"... and success thanks to planning and easy realization."

Dominik

Example of work

In our example it was necessary to realize a partially removable pro-arch prosthesis on six implants in the edentulous maxillary arch (Fig. 1). Straumann's Pro-Arch implant-prosthetic concept is an effective way for obtaining "fixed" prostheses in edentulous patients. It is based on manufacturing an implant supported restoration without inserting long inclined implants, or without having to perform bone grafts. That's why currently a study is being carried out at the clinic of reconstructive dentistry and gerodontology at the University's ZMK of Bern, under the direction Dr. Julia-Gabriela Wittneben, MedSc, in collaboration with Queen's University of Belfast/Great Britain.

The dental laboratory as a rule, is involved in the therapy from the early stages and uses a set-up based on study models and the determination of the intermaxillary ratios. This can be used at the same time as a temporary and as a basis for a surgical dima.

Manual operations: set-up and try-in in the mouth

First it was necessary to fabricate a set-up, based on prosthetic fundamentals. For this purpose, classic resin teeth were used. Teeth have a natural anatomical shape and you can choose between different morphologies. Within a comparatively short time, the set up was ready. We intentionally used a charismatic tooth arrangement, since this emphasizes the individuality of the patient (Fig. 2a and 2b).

Many patients want a well-made prosthesis that functions well. The dental technician can deliver this criterion using aesthetics and function that are confirmed in the mouth. The patient was satisfied with the final result.

Digital operations: manufacturing of the devata

Since in the individual "details" of a mounting of teeth activity dental technician's manual is indispensable, in the realization of the travata we

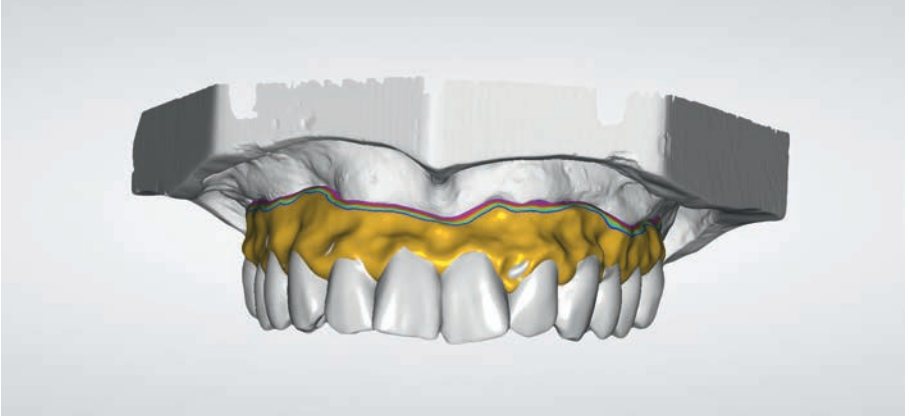


Fig. 6 — The digitized set-up served as the basis for construction of monolithic zirconium oxide crowns

Fig. 7 — Milling of crowns from an oxide of polychromatic zirconium

Fig. 8a

Fig. 8b

Fig. 8c

Figs. 8a to 8c — Zirconium oxide crowns with anatomical conformation were characterized with pastes 2-D and 3-D of the CeraMotion One-Touch concept. Supercolors are easy to use with minimal stratification

give preference to the CAD/CAM technology. The set-up confirmed in the mouth was then transferred to the CAD software and on this base was built the beam with a shape of the teeth shrunken by the anatomical point of view (Figs. from 3a to 3c).

Know-how in the choice of materials

Dental technicians want to imitate nature. In this respect they should not only consider aesthetics, but also take into account the characteristics of mechanical materials. The possibilities are more diverse than ever. For example, high performance modern polymers belong to a group of materials with high potential. In many cases, a polymer-based prosthesis can be more suited to hard, rigid materials, such as metal or ceramics. An example is implant-prosthetics: the stress factors can be reduced and spread out thanks to a beam material with a modulus of elasticity similar to that of bone. Polymer-based CAD/CAM belongs to the PAEK (polyaryleterchetone), group of materials - see the paragraph "About the PAEK materials"

About PAEK materials

The company EADT e.V. describes PAEK materials with the following convincing definition: "Currently polyetheretherketone (PEEK) is the best known representative of PAEK materials in dentistry. In addition to PEEK, there are other modifications of the material. These are distinguished by a variation of functional groups in the polymer chain. In this way you can change the characteristics of the material and adjust them as you please. In comparison to PEEK, the polyethercheton ketone (PEKK) is formed from a single group of two groups of ketones. In this way the polymer becomes a little stiffer, but optical features and chemicals still resemble each other. For both variants there are numerous indication fields, for example, crown and bridge, prosthetic bases and hooks for prostheses, implant abutments and telescopic elements. Currently, PEKK is offered by only one

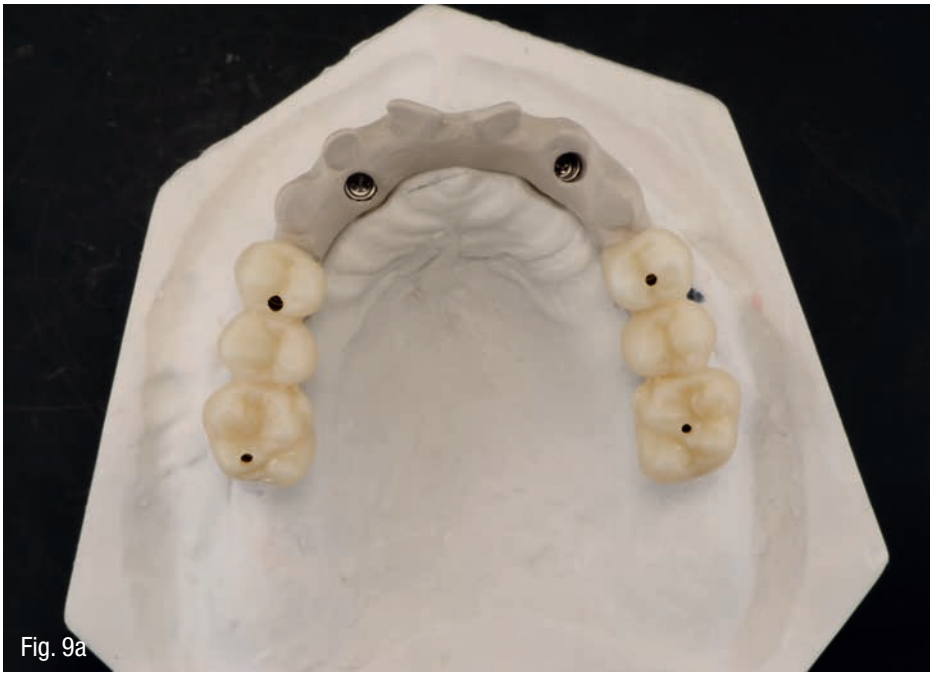


Fig. 9a


Fig. 9b


Fig. 9c

Figs. 9a to 9c — Adhesive cementation of single zirconium oxide crowns with PEEK beam


Fig. 10a

Fig. 10b

Fig. 10c

Figs. 10a to 10c — Application of matt rose on the beam in preparation for the aesthetic masking of the gingiva. Basic Gingiva BG34 was the background shade for the gingiva

Figs. 11a to 11c — After finishing the layering of the composite and after the final polymerization, the restoration was thoroughly polished and subsequently checked

manufacturer, i.e. from the company Cendres+Métaux under the name Pekkton Ivory. To optimize mechanical features, the material is filled with TiO2. Pekkton ivory contains about 10% TiO2 weight optically distinguished by a slightly grayish character. The material is suitable for different indications with reference to ductility and varies in the proportion of crystalline and amorphous parts.

Based on specific characteristics of the material, the PEKK Pekkton ivory was chosen. As with any prosthesis, long-lasting material stability and the sizing of the beam are important. In this regard we can orient according to known directives. Ideally, the cross section of a Pekkton beam should be increased by a minimum factor of 1.5 compared to metal alloy beams. CAD/CAM-assisted milling was executed with the parameters of milling for PMMA. Sharp milling tools are necessary and you must pay attention to ensure adequate cooling during milling. High-performance polymers are more sensitive to temperature compared to metal or zirconium oxide. Material temperatures above 160 °C can result in deformations of the beam. After having separated the rough workpiece to be milled, this is finished with cross-cut cutters with a maximum number of 15,000 revolutions per minute-1 (Fig. from 4a to 4c).

Manual operation: adhesion titanium bases

The accession of the PEKK beam to the Titanium bases requires maximum precision. Titanium bases were screwed on the analogues of the models for this purpose and the holes for the screws were closed. After sandblasting the surface of titanium bases with 110 µm and 3 bar aluminum oxide of pressure (Fig. 5a), we have moved on to salinize the metal surfaces (Fig. 5b). The areas of adhesion of the Pekk beams were conditioned with composite primer (Fig. 5c). Subsequently it was possible to apply the appropriate adhesive for this indication in the inside surface, and the Titanium bases were joined.

Digital operation: monolithic crowns

Economy and safety. For Pro-Arch prosthesis aesthetics, there are several possibilities. In this case we wanted to get a highly aesthetic result and for this reason we used masking ceramic aesthetics. For economics, they had to use monolithic zirconium oxide crowns. Since Pekk material achieves a certain reduction in masticatory forces, it is supposed that the high zirconium oxide hardness can thus be compensated. The set-up was digitized and served as a model for crowns. It was possible to transfer the teeth to monolithic crowns in an almost 1:1 ratio (Fig. 6). The teeth were milled in zirconium oxide which, with four layers of finely calibrated color, offers a soft internal chromatic characteristic. (Fig. 7).

Manual operation: characterization of the crowns

The monolithic zirconium oxide crowns must be conferred in such

Figs. 12a & 12b — Pekk beam provides buffering and cushioning capacity, produces individual aesthetic characterization, and is safe for monolithic zirconium oxide crowns

a way as to be highly aesthetic. To this end, the relatively recent One-Touch CeraMotion Paste concept was used, which is comparable to the classic supercolors. The 2-D and 3-D One-Touch CeraMotion pastes are specifically developed for the finalization and characterization of monolithic restorations. The size of the paste particles is adapted to the needs of the coloring technique (2-D). In this way it is possible to obtain an individual morphology in the incisal area or on the occlusal surface (3-D). Based on thixotropic characteristics of the masses, an ideal surface union is obtained with the possibility of a minimum stratification. Pastes come in many color shades and are translucent and they favor the photodynamics effect of the material. Single crowns were characterized with ready-made pastes to use (Fig. from 8a to 8c) with a sense of aesthetics and harmony, as well as with targeted details. It was therefore possible to give the crowns the necessary momentum in reference to a natural effect generated thanks to an internal play of colors, the monolithic restorations appeared alive and real. This result is otherwise only achievable with the layering technique, except that it is remarkably more wasteful.

Manual operation: tooth adhesive cementation

As a fastening material for zirconium oxide crowns, PEKK beam was used on double-curing Multilink Automix with optional photopolymerization, which is recommended by the manufacturer Ivoclar Vivadent for adhesive fixing of metal, metal-ceramics, ceramics of silicate and ceramic oxide, and composite. The surface of the PEKK beam was therefore improved with a diamond cutter (number of reduced revolutions, reduced pressure) and the adhesion surfaces were cleaned with alcohol. Zirconium oxide crowns and the Pekkton devata had to be subsequently sandblasted with aluminum oxide (110 µm, 2 bar). Then the surfaces of accession were conditioned and the crowns were adhesively cemented in accordance with the manufacturer's directives (Fig. from 9a to 9c).

Manual operation: masking aesthetics of the gingival aspect.

The individual aesthetic masking of the prosthetic gum is again classic craftsmanship. A photopolymerizable laboratory composite was used. After masking, using creativity and anatomical knowledge of foundations, the gum was designed (Fig. from 10a to 10c). The keratinized gum area was made in a light pink shade because as a rule spraying sanguine is less intense. Contrary to this, the mucogingival zone it is strongly sprayed (dark red) and mixed with venuzze.

A three-dimensional drawing of the gum for depth effect, arises from an alternation of convex and concave parts in the area of the alveoli and from slight dots, has been reproduced with pasty masses. The restoration was finally cured, then carefully polished and controlled (Figs. from 11a to 11c).

Summary

After the final polishing, both the crowns in monolithic zirconium oxide and the prosthetic gum impressed exhibit a natural depth of color. And what lies behind this result? A potpourri of know-how and possibilities. Thanks to the implant transformation using Straumann's Pro-Arch concept, the bone present could be used in the best possible way. The PEKK Pekkton ivory material offers optimal mechanical (high cushioning/capacity buffer)

and biological (high biocompatibility) characteristics (Fig. 12a and 12b). Monolithic teeth in zirconium oxide make "masking aesthetics" effective. With the 2-D and 3-D pastes, it was possible to get wonderful characterization.

The laboratory composite allowed for the individual creation of the gingiva thanks to the PEKK material. This relatively recent material demonstrates high potential especially in implant-prosthetics. In that regard there is already a multiplicity of publications giving dental technicians and dentists additional security for daily work.

Conclusion

CAD/CAM technology offers dental technicians a multiplicity of possibilities. However, it isn't always advisable to jump onto every new train that comes along. But any modern laboratory, must be able to compare what's new to what's existing. Among the many "innovations" that are regularly offered in specialized magazines and/or product catalogues, there are always some that optimize the work processes of dental technicians. A dental laboratory technician in step with the times must be able to present, in addition to his manual abilities, digital skills, solid knowledge in the field of scientific materials and an open mind that goes beyond his own backyard. Because the world is always changing! SM

About the Authors

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The master dental technician Patrick Zimmermann, in addition to his activity in the Zahnmanufaktur Zimmermann & Mäder, is an expert dental technician in the reconstructive and gerodontology course at the Dentistry Clinic of the ZMK in Bern (department of Prof. Dr. Martin Schimmel); he was for many years a member of the Central Board of Directors of Swiss Dental Laboratories (Training Section) and Chairman of the Board of the VZLS Foundation for Vocational Training and improvement in dental technology. He is a speaker at home and abroad.

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Erwin Eitler successfully completed his internship in Austria to become a dental technician in 2010 and subsequently worked for five years in Switzerland, before joining the team of Zahnmanufaktur Zimmermann & Mäder in Bern. He regularly takes part at conferences and courses and appreciates the collaboration of the laboratory with the University of Bern.

Odt. Gabriel Willauer
Gabriel Willauer successfully completed his internship in Lucerne to become a dental technician in 2009. Since April 2013, he has been part of the team of Zahnmanufaktur Zimmermann & Mäder. He is fascinated by the challenge of adapting each prosthesis to the anatomical shape, and shade of the teeth. Gabriel Willauer successfully completed the "Fixed Prosthesis" module at HFZ in 2016.