The i-Bridge X: Esthetics and stability

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In the following article, MDT Björn Maier and Dr. Wolfgang Bartsch describe an implant-supported restoration in the maxilla and demonstrate at the same time how important perfectly tuned teamwork is for treatment success.

There is a high demand for fixed teeth restorations whereby the sustainability of such restoration work should always be an important criterion during the design process. Nowadays, digitally supported technologies enable us to choose from a variety of materials and fabrication options. First of all, and most importantly, the best possible treatment must be determined for each patient and then systematically implemented by the team (fig. 1). Directly screwed-in implant bridges ensure a high level of reliability and can be removed by the dentist at any given time. Thanks to i-ProDensvscrew channel angulation of up to 30° we can confidently provide our patients with functional and esthetic restorations. Even through the COVID-19 pandemic, people in need of this treatment have realized the importance of restoring their function and aesthetics. The pandemic has reminded us of the importance of socializing and our enjoyment of dining out with friends and family.

The patient case

The patient has been coming to the dental clinic for a long time and on a regular basis. Routine check-ups and professional tooth cleaning enabled him to keep the situation in the maxilla stable for a long period of time (fig. 2). Despite all prophylactic measures, at one point the periodontium did not provide adequate stabilization and alternative treatment options had to be discussed.

The patient decided on a fixed implant-supported restoration which offers the appearance of natural teeth. We, as a team, always take into consideration that the patient's motor skills might decline with age and that the restoration must, therefore, be easy to clean .

The planning process and first work steps

We started by discussing the patient's requests and expectations and specified the detailed approach for the team. Thanks to digital communication tools such as Skype and FaceTime, distances between laboratory and dental clinic are no longer an issue since video conferences, permit participants to discuss treatment concepts and material choices in detail. Due to the current pandemic, this type of communication is very popular and new digital communication channels such as "Microsoft Teams" and "Jitsi Meet" have been introduced which offer a new flexibility by enabling the patient to participate in the consultation meeting with the dentist from the comfort of his/her home. Of course, data privacy aspects must always be respected.

Fabricating an interim restoration

We received the initial situation models by courier. First, we analyzed the articulated model using the Shimbashi chart and evaluated the abrasion loss followed by raising the models above the support pin.

Figure 1: From the 3D-printed mock-up and implant-based structure with angulated screw channels to the finished restoration.

Figure 2: The initial situation with severely damaged periodontium.

Figure 3: The teeth of the initial model were etched and, with the esthetic analysis, an interim prosthesis was produced.

Figure 4: The patient with the interim prosthesis after the extractions.

Figure 5: From the digitized interim prosthesis, a surgical template was printed and analog optimized.

Figure 6: Seven Camlog implants were placed to ensure an adequate primary stability which conformed to the bone structure.

Figure 7: The individual impression tray for an open impression was optimized with open source-software using the digitized surgical template and printed in the 3D printer.

Next, followed the etching of the teeth on the model. Using an analogous approach, we set up the prosthesis teeth according to esthetic and functional criteria, therefore creating an optimal situation (fig. 3) in which this interim prosthesis can represent our mock-up design for the subsequent treatment (fig. 4).

Implant planning and implementation

Following the dentist's specifications, a surgical template was produced which the dentist used as an implant positioning guide. For that purpose, the digitized interim prosthesis was matched to the jaw situation and optimized using the open-source software blender (fig. 5).

The data was then implemented using the additive approach and sent to the dentist as an implant insertion support.

In the dental clinic, seven Camlog implants were inserted in in conformity with the patient's bone structure. After the appropriate healing phase, the implants were exposed and we could start the actual prosthetic restoration work (fig. 6).

Taking precise impressions of the implant positions

An important factor for long-term success of directly screwed-in secondary structures is a highly accurate implant impression. Here we have achieved best results with directly screwed-in and interconnected impression posts. This means that, taking the direction of insertion into consideration, the screwed-in impression posts are loosely connected with dental floss. This facilitates the pattern resin application for the dentist (fig. 7). In order to prevent contraction distortion of the resin material, the joints are separated by a small milling instrument and then reconnected. The

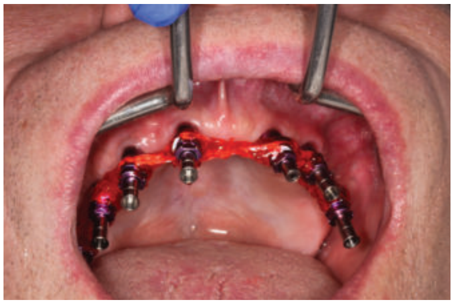

Figure 8: After the impressions were screwed in, they were splinted to each other with pattern resin.

Figure 9: For the bite registration, the worn interim prosthesis was measured using the Gutowski method and the measuring record was sent to the laboratory.

Figure 10: The working model with the removable gingiva mask.

Figure 11: The Camlog system provides screw-in registration posts which, in form of a patrix, serve as anchorage for the registration plates.

used for anchoring were polymerized into the light-cured acrylic of the registration plates (fig. 10 and 11).

This ensures that the registrations are securely fixed in the patient's mouth, allowing the dentist to focus on the registration process. For this purpose, the jaw is released via a jig followed by a bite registration with "gc bite compound". Once the patient consistently meets the target position after repeated closing motions we can continue to the next step (fig. 12).

Producing the framework using digital workflow

For producing the framework structure, two initial sets of data were used. For the digitalization of the implant model, the position of the model analogs was transferred using an optical scan, recommended for use with implants having the same diameter as the identical scan body. This avoids fabrication

Figure 12: In the current, case three registration posts were sufficient to ensure a stable fixation. The jaw is released via a jig ready for performing the registration.

impression is taken with an individual impression tray (fig. 8). that was produced using the 3D print technique (cara Print 4.0).

In order to properly prepare the registrations, the necessary data of the interim prosthesis are recorded in the Gutowski-protocol (fig. 9).

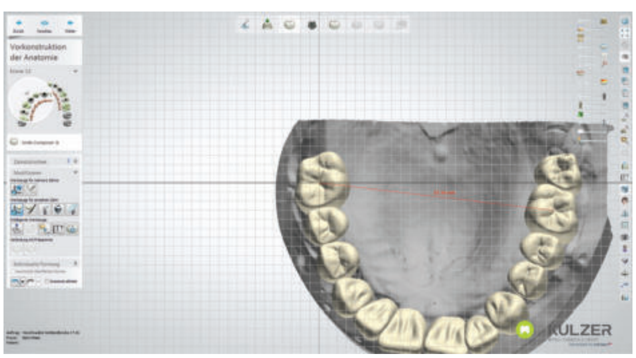

Figure 13: The nonprecious metal-based structure was designed digitally. The data of the optimized interim prosthesis were matched with the model situation. Based on this information, the structure was designed using the full-anatomical approach.

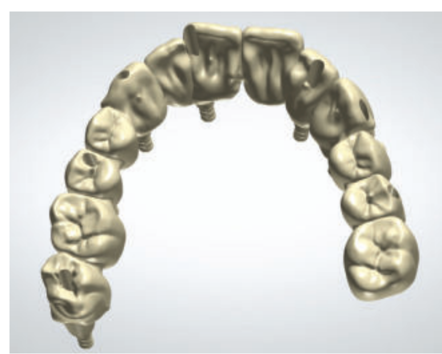

Figure 14: The full anatomical design was selected by the software for 3D printing and the printed result was sent to the dentist for the esthetic try-in.

Fabricating the implant models and registrations

The implant model included a removable gingiva mask. This facilitates the verification of the transition areas using the Sheffield-test.

Camlog's registration posts enable an easy and secure anchoring of the registrations. For this purpose, three registration posts were positioned on the model corresponding to the direction of insertion. The acrylic snaps

tolerances during the scan body fabrication. Though this is a little more time consuming due to the digitalization procedure, it prevents the accumulation of tolerances on the scan bodies.

Kulzer

Figure 15: With the help of 3D-print technology, the design data was used to print the prosthesis structure in the cara Print 4.0 unit out of a tooth-coloured acrylic.

Figure 16: The printed mock-up provides important information to aid with the finishing of the final restoration work.

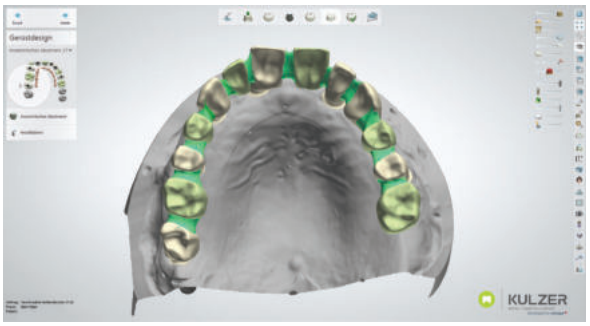

Figure 17: In the CAD-software, the full anatomical data is adjusted to the veneer thickness and the bridge joints are optimized.

Figure 18: The implementation of the framework structure is done using the additive approach.

Figure 19: The framework structure's passive fit is verified in its one-piece state using the Sheffield test.

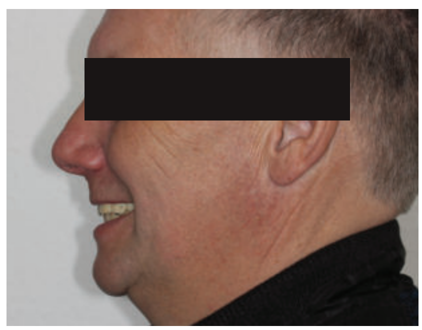

Figure 20: The 3D-printed aesthetic try-in model with the implants screwed in offers the patient a first look at the future prosthesis and phonetic and esthetic details can be discussed with the patient.

We matched the STL-data of the interim prosthesis to achieve an accurate framework structure. The design technician, therefore, had all necessary information crucial for the subsequent working steps (fig. 13).

By using a full-anatomical design approach, we achieved an optimal cusp-supported i-Brdige X structure. With the help of 3D-print technology, the design data (fig. 14) was used to print the prosthesis structure in the cara Print 4.0 unit out of a tooth-coloured acrylic (fig. 15). The mock-up that is screwed on the implants provides valuable information during try-in in terms of phonetics and the basal design of the final restoration (fig. 16).

Regarding the i-Bridge X design, in the CAD-software the full-anatomical data is then adjusted to the veneer thickness and the bridge joints are optimized (fig. 17). Virtual screw channels are superimposed and precisely positioned with the cursor. It is recommended to superimpose the full anatomical structure with an opacity of 60 to 80 per cent to obtain accurate information regarding the position of the screw channel openings.

Depending on the implant system and CAD-software used, virtual screw channels are not always displayed in an angled position. In that case, it is helpful to mark the position of the desired opening with the virtual wax knife. Anything to do with the analogous implementation is handled by i-ProDens directly. In general, an angulation of up to 30 ° is acceptable which leaves adequate room for adjustment

The finished data is then uploaded on i-ProDens's data platform or forwarded directly from the 3Shape DentalDesigner to the i-ProDens production centre. Afterwards the working model can be sent via dental courier to verify that the framework has an accurate and tension-free fit before it is returned to the laboratory (fig. 18 and 19).

One can distinguish between an additive or subtractive fabrication process. The additive process has the advantage of the nonexistent limitation of milling radii. Here the virtual design is implemented 1:1.

Verifying phonetics, esthetics, function and accuracy in the patient's mouth

The printed mock-up and the framework structure were sent to the dentist together with a prepared protrusion registration. The mock-up was then screwed onto three implants to verify the esthetic and gingival design with the patient. It is helpful for the detailed esthetic analysis to take a short video, preferably with the patient's own phone, of his/her different facial expressions and if a video exists of the initial situation, the improvement can be pointed out to the patient. The phonetic can be verified once the

Figure 21: Afterwards, the framework was placed in the mouth to verify the precise fit and, with the help of the prepared registration, the bite was checked again.

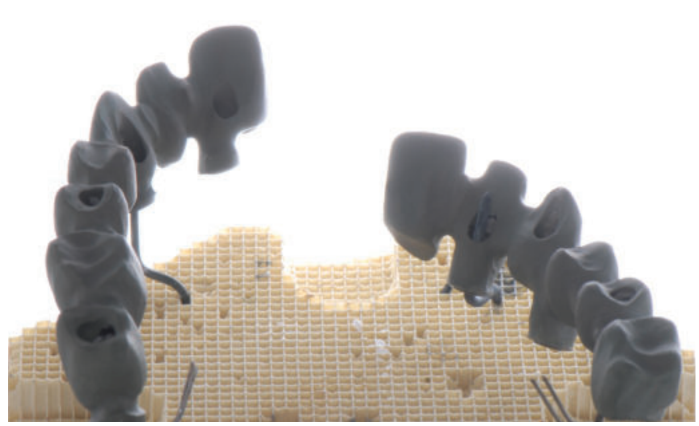

Figure 22: The framework was divided according to the physiological characteristics of the raphe-palatina-mediana and prepared for veneering.

patient gets accustomed to the volume of the mock-up which is different from that of the interim prosthesis's (fig. 20).

Next, we did the framework try-in, focusing exclusively on the accurate tension-free fit of the bridge structure. We verified the bite with the laboratory-created registration plate (fig. 21).

Figure 23: For the ceramic veneering, I used my triple-layering technique (TLT). The first step focuses on concealing the framework and adjusting the basic shade and brightness level.

Ceramic veneering using the triple-layering technique

Back in the laboratory, we took an impression of the previously in the patient's mouth verified and optimized mock-up. To limit physiological strain on the sutura palatina, we separated the structure between teeth 11 and 21 and prepared it for ceramic veneering. Ceramic veneering was performed using my triple-layering technique (TLT). I have talked about this technique in some publications and in seminars and have taught it in my veneering hands-on courses. Applying three-layer structures on top of each other facilitates the veneering process tremendously.

Figure 24: In the second step, type and age-specific characterization was applied with effect compounds.

We primed the non-precious metal structures with NP-Primer and covered the metal framework with the basic colour prior to applying HeraCeram Saphir ceramic (fig. 22). Next, we covered the implant joints with Oxyd-Stop (by Bredent). Oxyd-Stop can be precisely applied with a small brush and is dry in 30 seconds. After firing, it can be removed residue-free with 50 my glass polishing beads using a maximum of two bar blasting pressure, thereby preventing any loss of precision in the implant joints.

During veneering, we applied a thin layer of opaque dentine to the opaque structure. The edges are covered with alternate layers of opaque dentine and Value compounds (fig. 23). The fluorescent reflective Value compounds prevent the framework edge from shining through. The alternate layering of the two components creates an interplay of absorption and reflection. Afterwards we adjusted the basic shade and brightness with dentine and incisal material. During the second step of the triple-layering technique the age and situation-specific characterization was applied. In compliance with the selected basic shade, A3 mamelon structures were applied along with slightly calcified dental ridges alternating with selective high transparent areas (fig. 24). Sclerosis dentine areas were imitated using white effect materials such as OT10 or Value 1 and 2 compounds. The final third step of my TLT focuses on the completion of the morphology. Simultaneously, transparent materials can be used to add a touch of refinement and enhancement. I, therefore, like to call the third layer "light filter". In the HeraCeram product range, the incisal and OT-compounds are suitable materials. The Enhancer assortment offers the HeraCeram user a complete light filtering system.

Fig. 25

Fig. 26

Figures 25 - 26: The final third step of my TLT focuses on the completion of the morphology and fine-tuning via the light filter.

In the current case, the incisal areas were covered with a thin layer of OTA to simulate secondary dentine. In the mesial and distal areas, a slightly higher brightness level was achieved through the opal incisals. In order to increase the chroma level in the cervical third, we applied a thin layer of OTA (fig. 25).

Due to the minimal shrinkage characteristic of the HeraCeram veneer ceramic, we only needed to make minor corrections before the second firing (fig. 26). Any morphological fine details were applied at this stage.

Reocclusion and finishing

Finally the structure was sent again to the dentist with prepared registration plates to take an impression of the patient's protrusion and laterotrusion (fig. 27). With this information, we were able to program the patient's individual paths of motion into the articulator (fig. 28).

After precisely adjusting function, we could start with the surface design. I carefully add texture, in five sequential

Figure 27: An impression was taken of the protrusion and laterotrusion movements with the prepared registration plate.

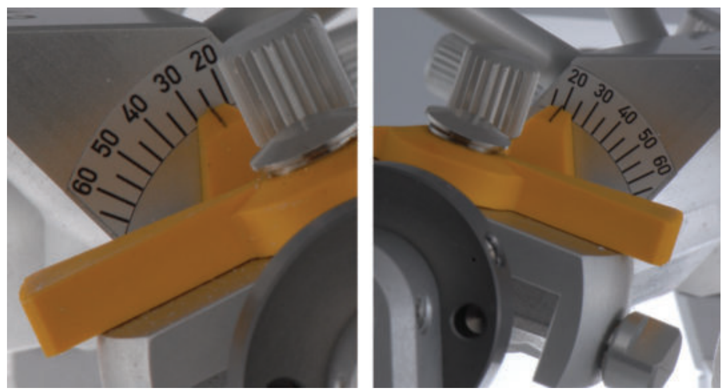

Figure 28: The registrations were programmed in the articulator to simulate the individual paths of motion in detail.

Figure 29: Texture add.

Figure 30: In order to achieve a natural looking surface texture, I did not use a glazing material. The individual gloss level was refined with a final polishing according to the convex and concave structures.

Figure 31: The subgingival non-veneered areas were polished to a high gloss with Signum HP-diamond.

steps, to the characterization of tooth growth (fig. 29). This is followed by age-specific smoothing of the surface texture in relation to the concave and convex intensity of the morphological characterized tooth surface. With the glaze firing, the sealing of the ceramic was completed.

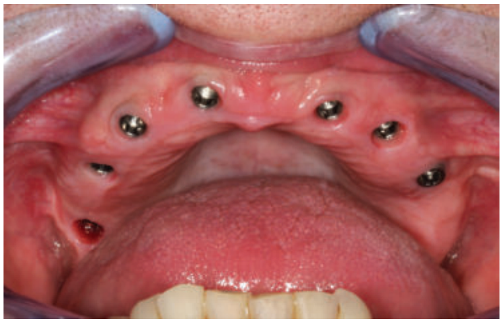

Figure 32: After the implant openings were exposed, the structure was screwed in place.

Figure 33: The patient with the veneered i-Bridge X restoration.

On principal, I prefer to slightly underfire the glaze . The final surface sheen was achieved with a Robinson brush and diamond polishing paste (Signum HP diamond) (fig. 30). The basal design is important with such fixed restoration work. Here the precise harmonization between adequate support of the soft tissue and self-rinsing properties of the implant joints is important. For that reason, the ceramic volume is applied 1:1 from the optimized mock-up in the patient's mouth.

Non-veneered subgingival areas were polished to a high sheen to prevent plaque deposits (fig. 31).

The work is now ready to be sent to the dentist and to be placed in the patient's mouth (fig. 32 and 33).

Conclusion

Fixed restorations are generally easily accepted by patients since they have the similar appearance of natural teeth and, due to the screwed-in fixation, they offer a considerable extent of stability and wear comfort. The long existing argument that screwed-in restorations are aesthetically inferior due to the visible screw channel openings in the labial area no longer holds true, thanks to the i-Bridge X technology developed by i-ProDens. ■