Special Edition

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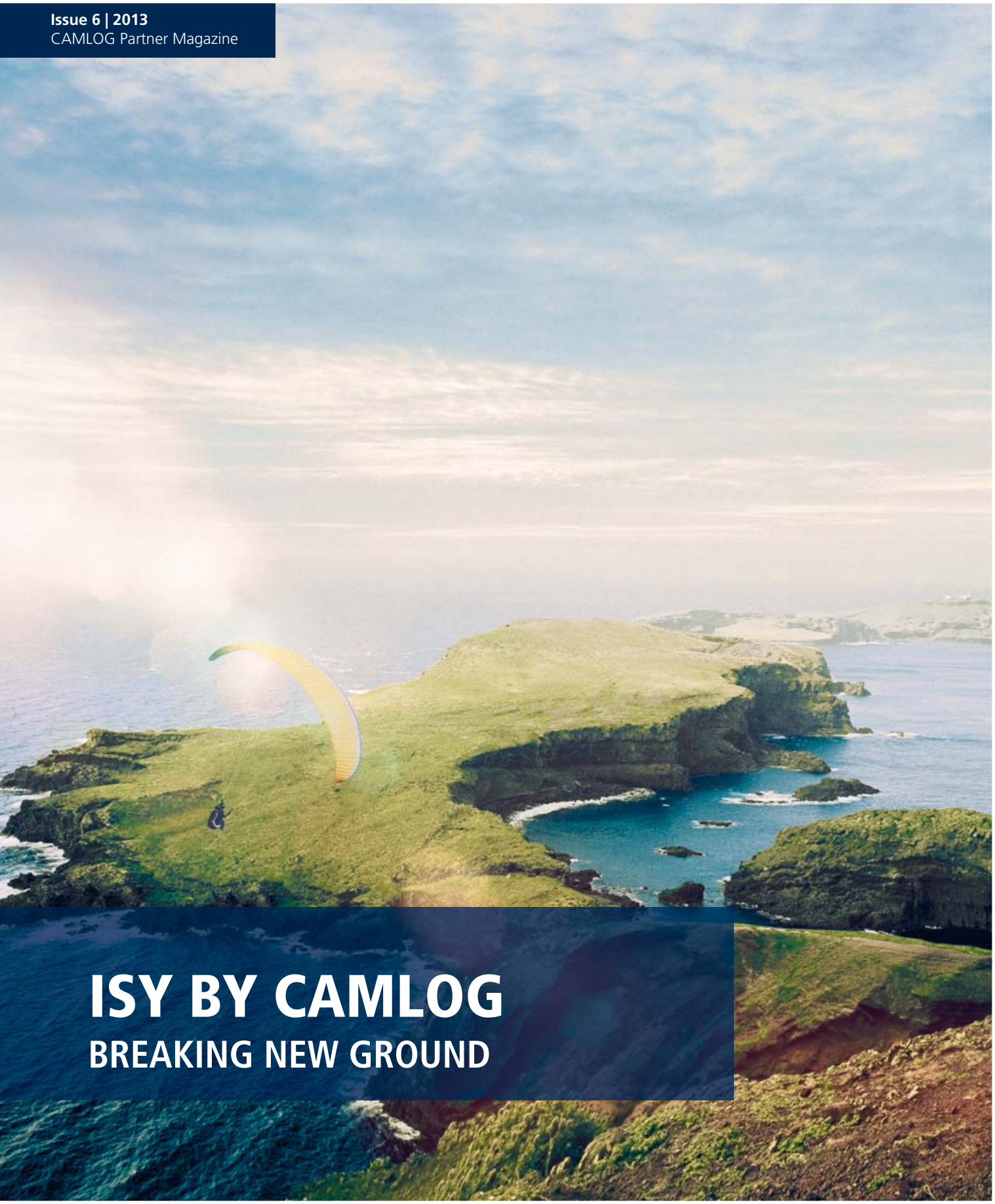
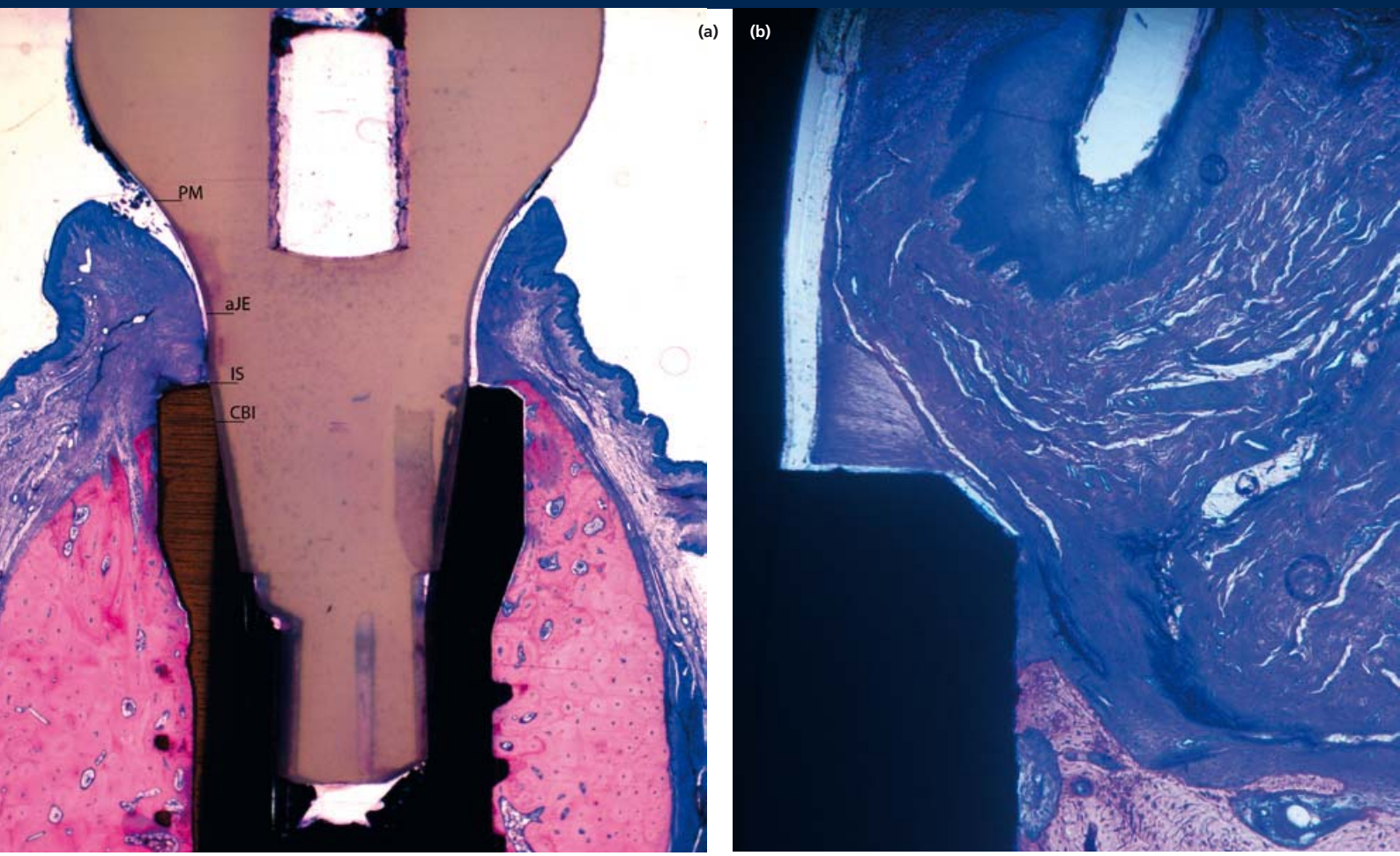
Issue 6 | 2013
CAMLOG Partner Magazine



ISY BY CAMLOG

BREAKING NEW GROUND



Two representative hard-tissue histologies (Paragon stains) which demonstrate the healing process after 8 weeks (original magnification x25). Mechanical manipulation of Ti and ZrO2 abutments led to ruptures of the junctional mucosa, a shift in gingival epithelium, and thus also the tissue zone, in apical direction, which led to crestal bone resorption. (a) control group, ZrO2- (b) test group, Ti at greater magnification aJE: apical extension of the gingival epithelium; CBI: most coronal bone-implant contact; IS: implant shoulder; PM: marginal section of peri-implant mucosa

IMPACT OF ABUTMENT DIS-/RE-CONNECTION ON PERI-IMPLANT HARD AND SOFT TISSUES:

A PRECLINICAL STUDY OF IMPLANTS WITH PLATFORM SWITCHING*

Kathrin Becker, Frank Schwarz, Düsseldorf

Introduction

A stable hard- and soft-tissue situation is a precondition for the long-term success of implant-supported restorations. Over the past few years, research has focused on modifications to the implant neck to minimize crestal bone resorption in the functional phase.

Preclinical studies with CAMLOG® and CONELOG® implants demonstrated that crestal restructuring processes could be reduced considerably by step formation between the abutment and the implant body with CAMLOG K-Line implants, when compared with the older J-Line as well as with implants without step formation.

Another demonstrated core finding was that the length of the inner gingival epithelium could be minimized for abutments inserted according to the platform switching principle (Becker et al. 2007, 2009).

This results in wider connective tissue areas in the sulcus for sealing the abutment versus the bone. Clinical and preclinical research results to date show no disadvantages of platform switching according to current thinking and tend to show advantages versus conventional procedures without steps.

However, early studies by Abrahamsson et al., 1997, documented that manipulation of the abutment components, a routine occurrence in prosthetic restorations, can have negative effects on the crestal bone and soft-tissue structures.

The integration of dental implants into the soft-tissue was improved through various modifications. Whereas the implant types (single vs. two-component) and the method of healing (submerged vs. open) had no effects on the peri-implant mucosa

*Original paper: Becker K., Mihatovic I., Golubovic V. & Schwarz F. Impact of abutment material and dis-/re-connection on soft and hard tissue changes at implants with platform-switching. (2012) J Clin Periodontol 39, 774-780

and the epithelium in animal models, the height of the gingival epithelium could be reduced by increasing the surface roughness of the abutment (Glauser et al. 2005). The material used (titanium vs. gold) had no effect on the dimension and quality of soft-tissue attachment (Vigolo et al. 2006, Abrahamsson & Cordaropoli 2007).

Mucositis, which was observed in many clinical studies in the functional phase of implant-supported prostheses, exemplifies that the peri-implant soft tissue is highly sensitive to inflammation stimuli despite high biocompatibility of the abutment. In experimental investigations on the healing of dental implants, it has so far been usual to allow the implants to heal without interference. However, this does not correspond with present practice as abutments are as a rule already manipulated mechanically several times during the healing phase, for example, when inserting impression posts. When using round healing caps, the rotary movement may possibly lead to damage of the mucogingival integration.

The role of this mechanical manipulation on the healing process has so far been unknown.

As part of a preclinical research project sponsored by the CAMLOG Foundation, it was to be examined whether zirconium healing caps showed differences when compared with titanium healing caps (Becker et al. 2012). It was also to be examined whether dis-/re-connection of healing caps during the healing phase could lead to changes in the expansion of the inner gingival epithelium and to crestal bone changes.

Study design

The study was conducted on three male foxhounds (age 12–24 months, weight 42 +/- 4 kg). After extraction of the 2nd, 3rd and 4th premolars as well as the first molars in all four quadrants, this was followed by an eight-week healing phase. Then, four implants were placed in the maxilla in each case. These were titanium implants with sand-blasted and acid-etched surfaces (diameter 3.8 mm, length 9 mm, CONELOG® Screw-Line implants; CAMLOG Biotechnologies AG, Basel, Switzerland); the healing abutments for the implant with Ø 3,8 mm had a height of 4 mm; the horizontal mismatch was 0.4 mm, the surface roughness was more pronounced for the ceramic abutments (titanium abutments: SRa = 0.21 µm, Ra = 0.20 µm; zirconium dioxide abutments: SRa = 0.43 µm, Ra = 0.43 µm). Placements of the titanium and zirconium abutments were at random.

The healing period for the implants (n=12) was 8 weeks. Mechanical manipulation of the abutments was conducted at 4 and 6 weeks in the test group, whereas the abutments in the control group were allowed to heal without interference. Assignment to the test and control groups was randomized using the RandList® software (DatInf GmbH, Tübingen, Germany). A plaque control program prevented the formation of bacterial biofilms in all groups.

The animals were sacrificed after an eight-week healing phase and the tissue to be examined fixed in formalin. In further steps, the tissue was dehydrated and embedded in methyl methacrylate (Technovit 9100 Neu, Heraeus Kulzer, Wehrheim, Germany). This was followed by precision sawing using a diamond saw (Exakt®; Apparatebau, Norderstedt, Germany) in vestibulo-oral direction and embedding in acrylate cement (Technovit 7210 VLC, Heraeus Kulzer). Finally, the specimens were ground down to a thickness of approx. 40 µm in order to be analyzed under a transmitted light microscope (Olympus BC 50; Olympus). The histologies were digitalized using a CCD camera (Color View III, Olympus, Hamburg) for histomorphometric analysis.

In each case, the oral and vestibular reference points were: IS (implant shoulder), PM (marginal section of the peri-implant mucosa), aJE (apical extension of the gingival epithelium) and CBI (most coronal bone-implant contact). The distances between the reference points were measured using the Cell D® (Imaging System, Münster, Germany) software.

The statistical analyses were performed using commercial software (PASW Statistics 20.0; SPSS Inc., Chicago, IL, USA).

Results

The soft tissue showed no signs of inflammation for either the titanium or the zirconium dioxide abutments. In the control group, the aJE was mostly coronal and otherwise at the level of the IS. In case of two zirconium abutments, the IS was subcrestal. In the test group, a gap was observed between the soft tissue and the abutment, however, the aJE was mostly at the height of the IS or slightly above.

In the control group, the mean values for PM-aJE and IS-aJE were comparable for vestibular and oral, whereas aJE-CBI and IS-CBI were elevated for the titanium abutments.

In the test group, all measured parameters were elevated compared with the test group, whereby elevation was more pronounced for the zirconium abutments.

Discussion

The objective of this pilot study was to analyze the significance of mechanical abutment manipulation during the healing phase for zirconium dioxide and titanium abutments.

In a previous experimental study, it was shown that under undisturbed healing, zirconium abutments demonstrate better soft-tissue conditions than titanium abutments in terms of the measuring parameters PM-aJE and IS-CBI (resp. mean) after healing phases of 2 and 5 months (Welander et al. 2008). The results of this study showed comparable values for titanium to previous studies for the control group without changing abutments, where the healing of implants was analyzed for similar abutment and implant configurations (Becker et al. 2007, 2009). In this study, too, a tendency to a slightly superior soft-tissue situation was observed in the control group for the zirconium material in comparison to titanium. In this respect, the results of Welander et al., 2008, were confirmed.

Interestingly, the test group with changed abutments showed contrary results.

The fact that the measured parameters for zirconium abutments were higher in the test group but rather lower than for titanium abutments in the control group could be an indication of better attachment between the zirconium abutment and the soft tissue under undisturbed healing. In case of firmer attachment, it is to be

expected that manipulation may lead to greater damage so that the inner gingiva epithelium may expand more after changing abutments than with titanium abutments.

The question as to whether abutment manipulations impair the healing of dental implants was first examined in an experimental study by Abrahamsson et al., 1997. In this study, the titanium abutments were loosened five times during the healing phase and then tightened again (in each case once per month over 5 months). This led to an elevation of the parameters PM-aJE, aJE-CBI and IS-CBI versus the control group, in IS-CBI and PM-IS, the increase was significant.

In this study, the aJE was not below IS in both groups, which means that the apical expansion of the gingiva epithelium was limited by the horizontal mismatch. The histological observations and the elevation of all parameters in the test group support the assumption that loosening of the abutments during the healing phase leads to ruptures and may thus negatively affect long-term success.

Further practical studies have already demonstrated how sensitive soft tissue is during the healing phase. Structural and dimensional changes in soft-tissue attachment have already been observed for repeated probing at short intervals for single-component implants, in specific, the mean for PM-aJE was increased in the study (Schwarz et al. 2010).

In summary, this study shows that the present clinical practice of changing abutment components as part of prosthetic restoration is associated with negative effects of the mucogingival integration of enosseous implants and that these negative effects are more pronounced for zirconium than for titanium material.

Despite the limited validity of a preclinical pilot study, the findings indicate that the present clinical routine is possibly associated with disadvantages for the long-term success of implant-supported restorations. Further investigations are necessary to clarify this question and to propose solutions.

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CAMLOG FOUNDATION RESEARCH AWARD – 2012/2013 LAUNCHED FOR THE THIRD TIME

For the third time, the CAMLOG Foundation announced its renowned CAMLOG Foundation Research Award. The Research Award is presented every two years at the International CAMLOG Congress and is open to all young, talented scientists / researchers and dedicated professionals from universities, hospitals and practices under 40 years of age.

The expected extraordinary scientific papers must be published in a recognized scientific journal and can be submitted either in English or German. They should treat one of these topics in implant dentistry or related disciplines:

- ☑ Diagnostics and planning in implant dentistry
- ☑ Hard- and soft-tissue management in implant dentistry
- ☑ Sustainability of implant-supported prosthetics
- ☑ Physiological and pathophysiological aspects in implant dentistry
- ☑ Advances in digital procedures in implant dentistry.

The contributions will be judged and evaluated by the CAMLOG Foundation Board.

The winner of the CAMLOG Foundation Research Prize 2012/2013 will be given the opportunity of presenting his/her work to a wider audience on the occasion of the 2014 International CAMLOG Congress. Furthermore, the authors of the three best contributions will receive attractive cash prizes (each EUR 10,000, EUR 6,000 and EUR 4,000).

The entry conditions and the mandatory registration form can be downloaded from www.camlogfoundation.org/awards. Registration deadline is November 30th, 2013.

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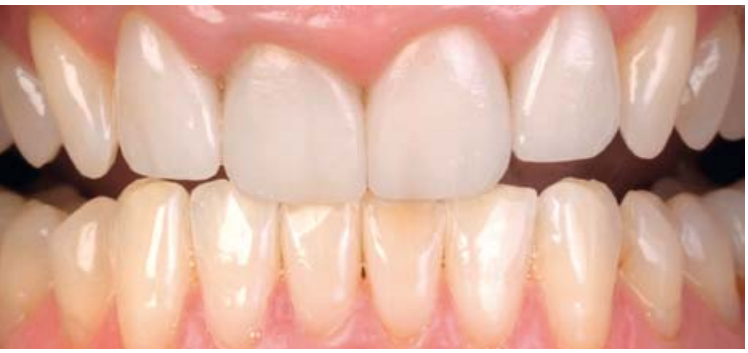

Fig. 1: The female patient wanted a new restoration with bright, natural-looking crowns in the regions 12 to 22.

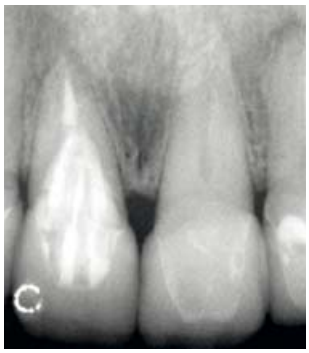

Fig. 2: Tooth 11 is not worth saving and to be replaced with an implant.

Fig. 3: Self-made photos and the situation models were evaluated for esthetic analysis, and all details diligently recorded on an appropriate form.

IMMEDIATE IMPLANTATION AND FULL-CERAMIC RESTORATION IN THE MAXILLARY ANTERIOR REGION – AN INDIVIDUAL AND INTERDISCIPLINARY TREATMENT CONCEPT[1]

Dr. Arndt Happe and Andreas Nolte, both Münster

Implant-supported, single-tooth crowns in the esthetic zone are a special challenge. This applies even more when immediate implantation is planned – in case of insufficient bone volume and a thin biotype. A whole chain of critical factors need to be observed here, from implant positioning [1, 2], hard and soft-tissue management [3, 4, 5] and the natural design of the crown [6]. These days, a number of digital methods are available to simplify the process and make it more safe [7]. Depending on the initial situation, i.e., maximum esthetic demands, many teams however prefer analog methods as in the following example.

Initial findings and planning

A young, female patient with full-ceramic crowns on teeth 12 to 22 wishes for a new restoration **(Fig. 1)**. The new restorations are to look bright and natural. The medical history is inconspicuous, the gingival type is classified as being thin. Tooth 11, with root treatment, cannot be saved and needs to be replaced with an implant. The reason is a weakening of tooth substance, resulting from excessive cavitation as part of post-endodontic restoration **(Fig. 2)**. In addition, the existing crown keeps coming off due to poor retentive design of the abutment.

To obtain the most realistic picture possible of the initial situation, the dental technician photographs the patient in his laboratory. Using the photo and the initial models, he defines the shape and color of the planned restoration and carefully analyzes their position in the arch for the temporary restoration **(Fig. 3)**. On the basis of the data obtained, a temporary bridge is fabricated from teeth 12 to 21 for the day of extraction of tooth 11.

Immediate implantation and temporary restoration

In order to extract tooth 11 with as little trauma as possible, the surgeon first severs the periodontal fibre system with a periotome **(Fig. 4)** and expands the coronal alveolar gap with piezo-surgical instruments. First the crown is luxated and extracted with extraction pliers, then the root, again with piezo surgery, a sharp lever and diamonded pliers. This reveals that the thin buccal bone lamella is connected to the root **(Fig. 5)**. The osseous margin of the alveole is examined carefully with a periodontal probe (bone sounding).

Despite a lack of bone wall, an immediate implantation as planned is to be performed according to the concept of the University Clinic Mainz [8]. With the aid of the deep-drawn template prepared in the laboratory, the positions are marked prior to preparing the implant bed **(Fig. 6)**. Pilot drilling and further drilling steps are performed by the surgeon without template and drill extension for

[1]Volume 2 of the video compendium, "Implant prosthetics" published by Quintessenz-Verlag 2012.

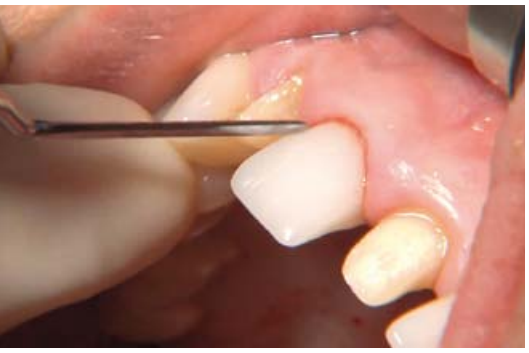

Fig. 4: After removing the temporary crowns on 12 and 21, the supra-alveolar periodontal attachment of tooth 11 is severed with a periotome.

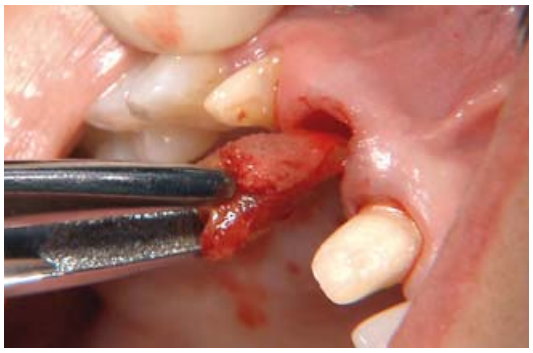

Fig. 5: The root is extracted following atraumatic removal of the crown. The buccal bone lamella connected to the root surface was lost during the process.

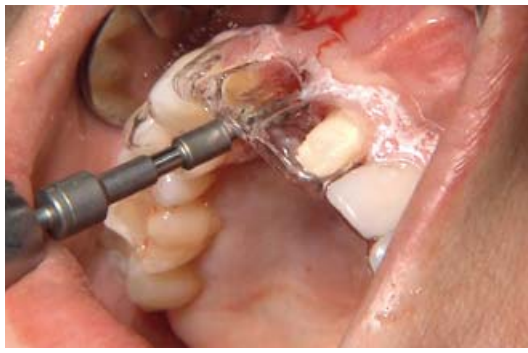

Fig. 6: The palatal margin of the alveole is marked with the pilot drill through a deep-drawn template prepared in the laboratory.

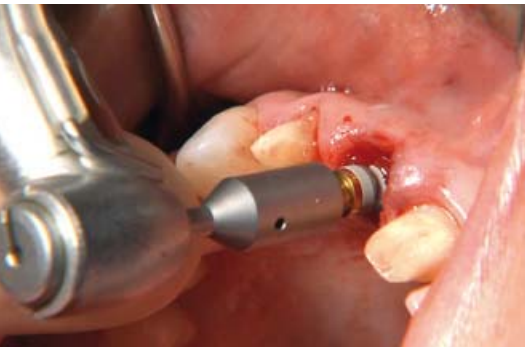

Fig. 7: When inserting the implant (CONELOG®), the surgeon orients himself along the palatal bone wall.

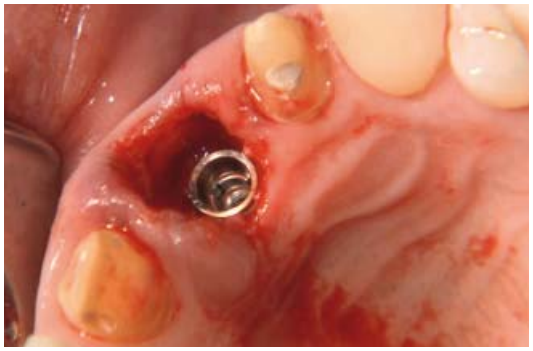

Fig. 8: The implant is palatally displaced in the correct position, the buccal bone lamella no longer exists.

Fig. 9: The position of the implant in the dental arch can be checked with the aid of the template.

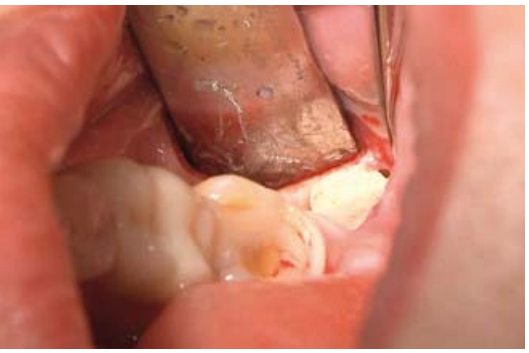

Fig. 10: A retromolar bone cylinder was harvested with a trephine drill to obtain autologous bone for augmentation of the buccal lamella.

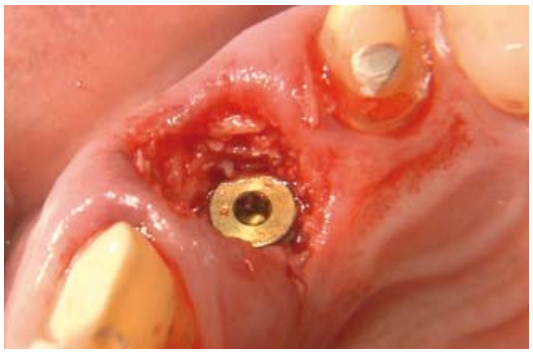

Fig. 11: The space between implant and buccal soft tissue is filled with a mixture of own bone and bovine bone replacement material.

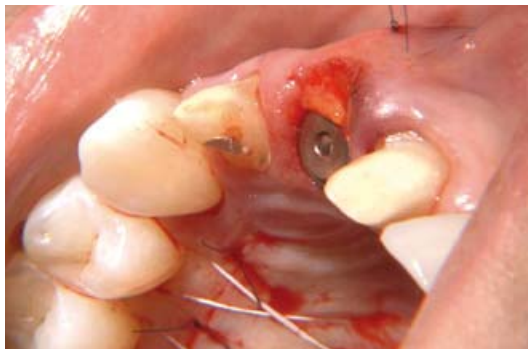

Fig. 12: To obtain optimal buccal contours, a palatally harvested connective tissue graft is drawn under the soft tissue and sutured.

optimal cooling. Insertion of the implant (CONELOG®, diameter 3.8 mm, length 13 mm) **(Fig. 7)** is also performed without a template.

Correct three-dimensional orientation of the implant can be checked with the final form drill and using the drill template. The buccal implant shoulder should be three millimeters apical of the marginal soft tissue and distinctly palatal to the dental arch **(Figs. 8** and **9)**. This ensures that the subsequent implant-supported crown can be screwed in palatally. The gap between implant and buccal soft tissue is filled with bone material. This is a mixture of autologous bone gained during preparation. Retromolarly harvested granular own bone and bovine bone augmentation material act as protection against resorption **(Figs. 10** and **11)**.

To obtain the best possible soft-tissue conditions in the sense of a thicker gingiva type, the surgeon harvests a connective tissue graft from the palate. Using the tunnel technique according to Azzi [9, 10, 11], this is pulled between the bone granulate and the buccal soft tissue and fixed with a monofilament, non-absorbable suture material **(Fig. 12)**. Then a CONELOG® healing cap wide body of 4 mm height is screwed in and the temporary bridge cemented **(Fig. 13)**. This supports the soft tissue, but has no contact with the healing cap, so that the lower section of the pontic can be cleaned with super floss. **Figures 14** and **15** show the postoperative X-ray and

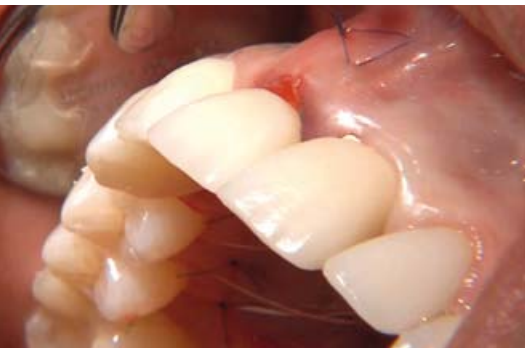

Fig. 13: The temporary bridge is cemented with the healing cap without contact to the pontic.

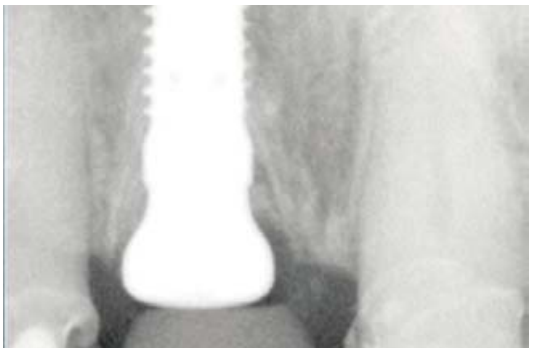

Fig. 14: The subcrestal bone position and good cervical join of the temporary bridge are shown on the postoperative X-ray.

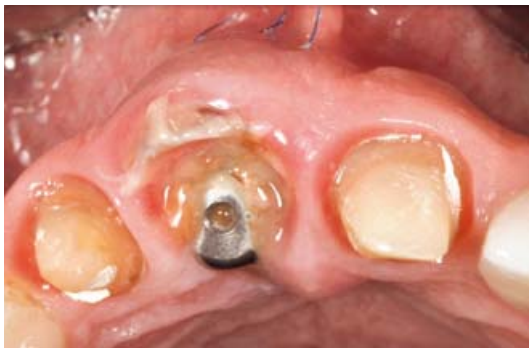

Fig. 15: Good healing and successful integration of the connective tissue graft are evident one week after immediate implantation. The white-yellow deposits are fibrin.

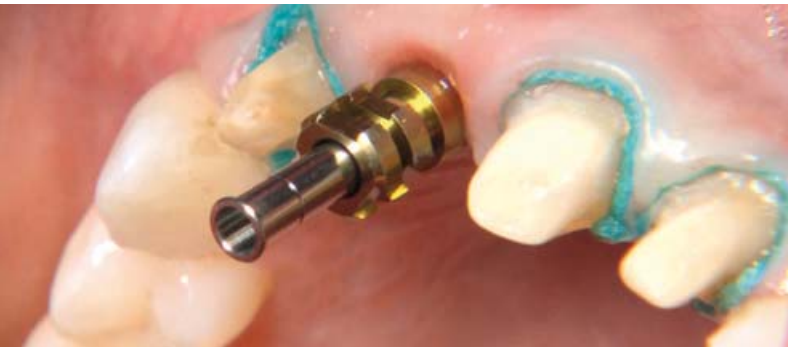

Fig. 19: Impression-taking of the prepared teeth and the implant.

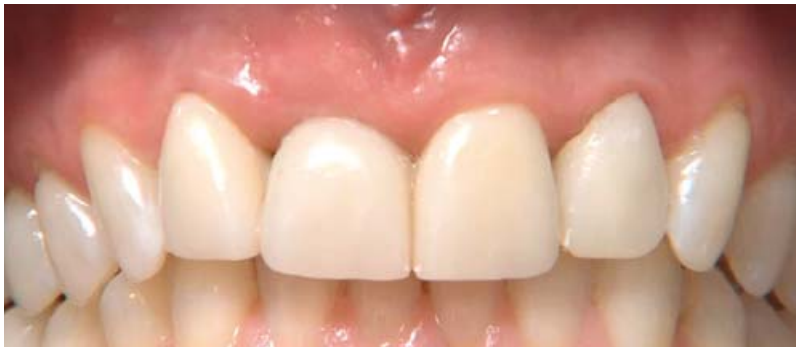

Fig. 20: Following re-insertion of the temporary bridge, excess soft tissue is revealed in the area of the implant (position 11).

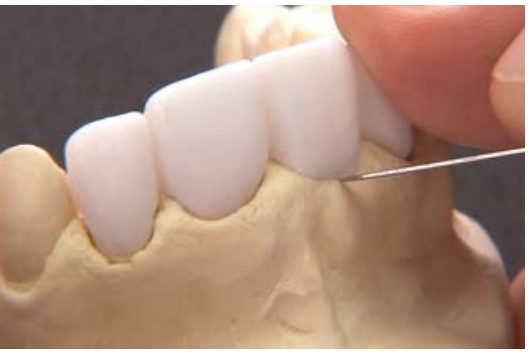

Fig. 24: The marginal border of the planned implant crown is transferred to the plaster surface.

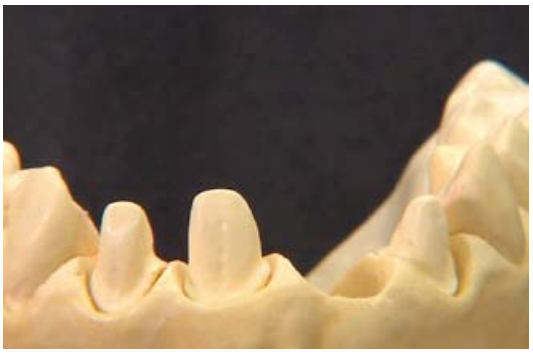

Fig. 25: The peri-implant emergence profile was expanded and the papillae sharpened to provide a harmonious gingiva profile.

Fig. 26: Optimal hold of the wax-up during try-in through filled implant interface.

the situation during check-up one week after immediate implantation. After three months of implant healing, the peri-implant and periodontal tissues are ready for final impression-taking **(Figs. 16** and **17)**. To this purpose, double 0 sutures soaked in glycerine were placed in the sulci and the preparation borders placed slightly sub-gingivally as part of final fine preparation. Then a thicker retraction cord, strength 0, is placed, which is soaked in epinephrine (adrenaline) **(Fig. 18)**. The healing cap is unscrewed **(Fig. 18)** and a CONELOG® impression post for open trays screwed in **(Fig. 19)**. Impression-taking is performed after drying and removal of the thick retraction cords **(Fig. 19)** in one step with an open individual tray and a two-phase polyvinyl siloxane (A-silicone). Following arbitrary transfer of the occlusal relations with a bite fork, face bow and bite registry, the healing caps and temporary bridge are re-inserted. A temporary crown was fabricated for tooth 22 **(Fig. 20)**. The marginal gingiva in the region of the implant should be moved slightly in apical direction with the definitive restoration due to the excess tissue.

Fabrication of abutments and final crowns

Using super-hard plaster, the dental technician fabricates root-shaped (conical) stumps with protection against rotation. These are placed in the impression to fabricate the master model and extended with wax pins **(Figs. 21** to **23)**. A new wax-up is prepared on the basis of the updated esthetic analysis and the outer cervical contour of the implant restoration is transferred to the model **(Fig. 24)**. The anatomical shape of the emergence profile is then created with a

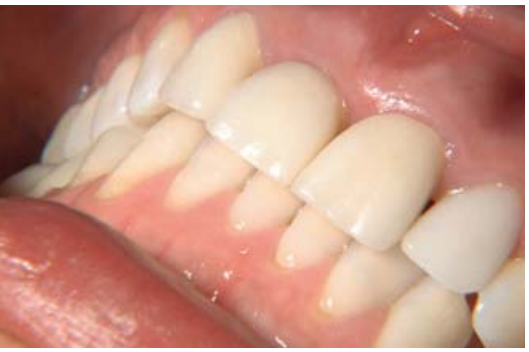

Fig. 16: Following a three-month healing time, the implant has been successfully osseointegrated and the soft tissue has stabilized for final impression-taking.

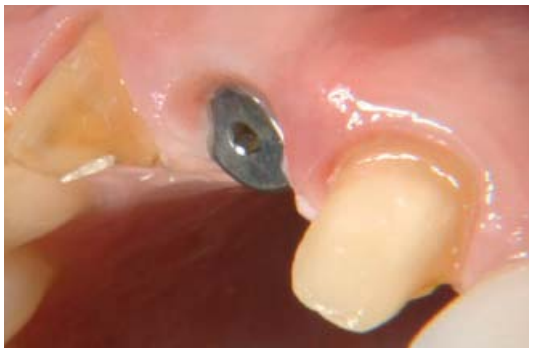

Fig. 17: The peri-implant soft tissue is well formed and largely irritation-free under the temporary bridge.

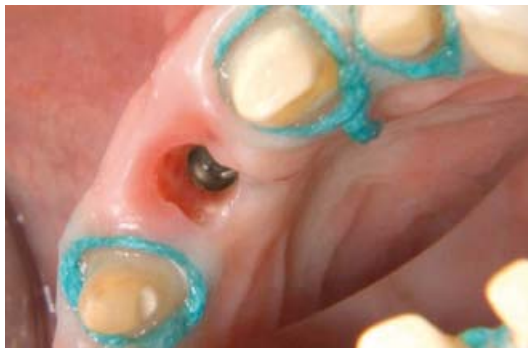

Fig. 18: Good perfusion of the peri-implant soft-tissue well can be observed. Buccal tissue thickness exceeds three millimeters.

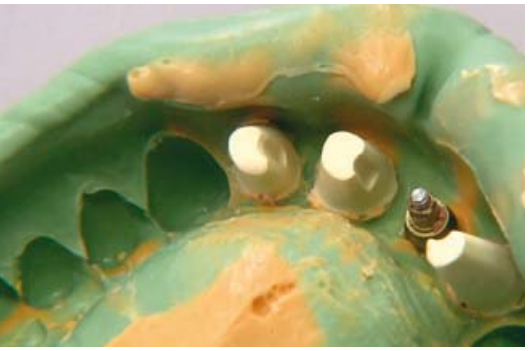

Fig. 21: Individual stumps made of super-hard plaster with grooves to protect against rotation, are fixed in the impression with instant adhesive.

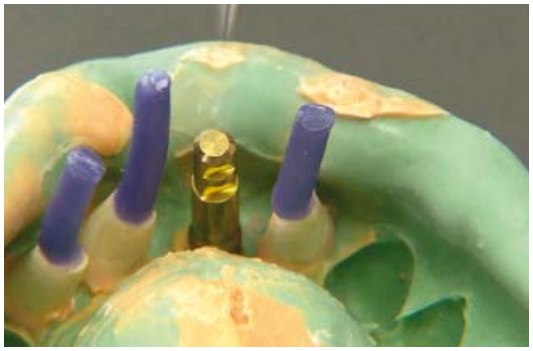

Fig. 22: Preparation of the master model. The wax pins serve as access to the stumps on the master model.

Fig. 23: The precise periodontal and peri-implant soft-tissue situation is represented on the master model.

Fig. 27: Overview of abutment options: (from left): CONELOG® Esthomic abutment (gingiva height 1.5-2.5 mm) prior to and after customizing, CONELOG® Titanium base CAD/CAM.

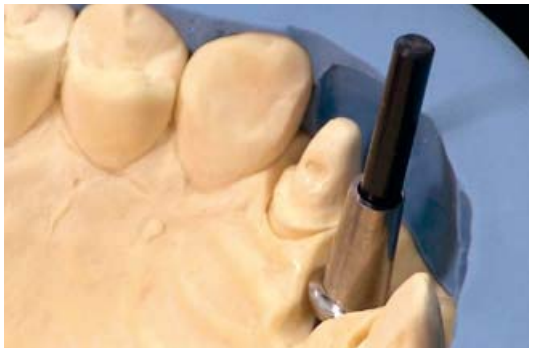

Fig. 28: The Esthomic abutment, extended with a bonding aid, shows the palatal positioning of the access channel.

Fig. 29: Customizing the primary abutment ensures sufficient coating strength of the zirconium oxide abutment.

fine milling machine. The implant crown will thus be given a natural emergence contour and will not be recognized as a denture. The papillae are slightly sharpened and smoothed to give an optimal gingival contour. The optimized shape of the papillae avoids concavities occurring later in the cervical, slightly subgingival ceramic areas, which are difficult to clean and can lead to irritation of the gingiva **(Fig. 25)**. The wax-up is fitted with a pin at the implant position, which engages with the implant interface for better fixation of the wax-up during try-in **(Fig. 26)**.

A suitable abutment is selected from the CONELOG® Esthomic abutment set and the silicone indexes based on the wax-up. In this case, the CONELOG® Titanium bases CAD/CAM are too low due to the apical position of the implant shoulder. Therefore, the dental technician decides on a considerably longer, straight CONELOG® Esthomic abutment, which is customized for use as a titanium bonding base **(Figs. 27** to **29)**. He models a secondary abutment with wax on the customized titanium base (primary abutment), which is to be fabricated from zirconium oxide. Subsequent bonding with the titanium base results in a hybrid abutment with full anatomical contours, both in the palatally and subgingivally positioned emergence area through the soft tissue. Room is left on the buccally visible area for a pressed ceramic veneer to be fixed by bonding **(see Fig. 30)**.

Using a double scan, the dental technician imports the three-dimensional shape of the primary abutment and the wax model of the secondary abutment into the planning software (Abutment Designer™, 3Shape) **(Fig. 30)**. Then the secondary abutment is ground from zirconium oxide ceramic with

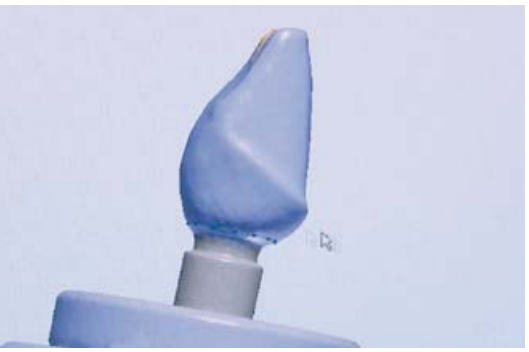

Fig. 30: The titanium base and the completed model of the secondary abutment are scanned in the laboratory. Buccal space is left for the planned pressed ceramic veneer.

Fig. 31: The sintered abutment left (without) and right *with* fluorescent solution treatment.

Fig. 32: Firing of a highly fluorescent, etchable zirconium oxide veneer ceramic. The shape of the abutment is optimized prior to modeling the press cap.

Fig. 36: Esthetic try-in: the patient and her dental technician, Andreas Nolte, appreciating the highly successful outcome and nearly completed treatment.

Fig. 37: The pressed ceramic veneer is mounted on the previously bonded hybrid abutment by bonding with dual-curing composite.

Fig. 38: The transitions between the abutment and the veneer are smoothed and polished to a high gloss with a brush and polishing paste.

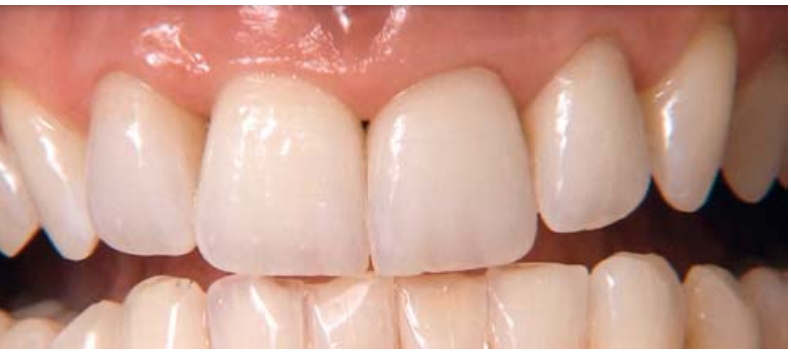

Fig. 42: The crowns on teeth 12, 21 and 22 and the implant restoration on 11 fit harmoniously to the dental arch and the remaining teeth.

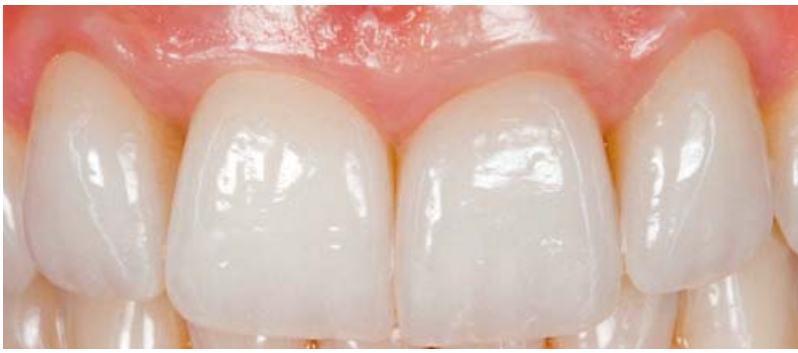

Fig. 43: The close-up shows the healthy peri-implant soft tissue and the natural surface of the restorations.

CAM technology and immersed unsintered into a fluorescent solution. **(Fig. 31)**. The screw channel is prepared prior to sintering. As zirconium oxide cannot be etched, the dental technician needs to fire a thin layer of etchable, highly fluorescent zirconium oxide veneer ceramic onto the buccal surface and preparation margin of the hybrid abutment prior to modeling the cap for the pressed ceramic veneer **(Fig. 32)**. Fluorescence ensures the transmission of light in the gingival area. This has a positive effect, particularly in case of a thin gingiva. Then, he can fabricate and veneer the pressed ceramic caps for the crowns and veneers **(Figs. 33 to 35)**.

After a successful esthetic try-in in the laboratory **(Fig. 36**, **45)**, the individual parts can be combined. First the titanium base is sand-blasted and conditioned, then the secondary zirconium oxide abutment is also conditioned. Both parts are bonded with special composite. Then the inner side of the veneer and the burned zirconium oxide veneer ceramic of the hybrid abutment are etched with hydrofluoric acid, conditioned and bonded with dual-curing composite **(Fig. 37)**. Then, the transition areas are smoothed and polished **(Fig. 38)**.

Insertion

The crowns are mounted by bonding and the implant-supported veneer crown is screw-retained **(Figs. 39 and 40)**. This is followed by carefully checking the approximal contacts and the function.

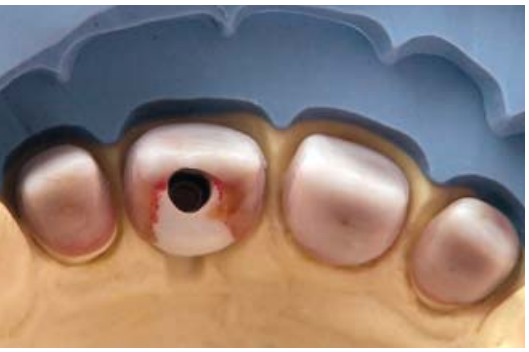

Fig. 33: The layer thicknesses for veneering the pressed ceramic caps are checked with the aid of the vestibular, twice-divided silicone index.

Fig. 34: Modeling of the mamelon for the implant-supported veneer from a palatal view.

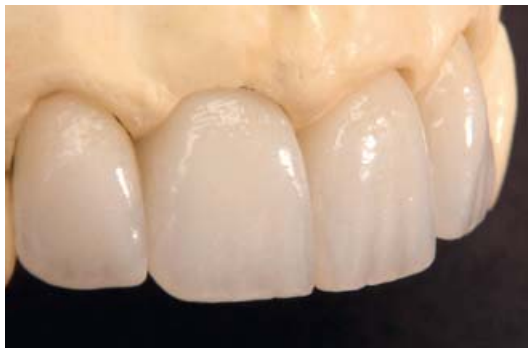

Fig. 35: After glaze firing and polishing, the natural anatomy and surface characteristics of the restoration are checked.

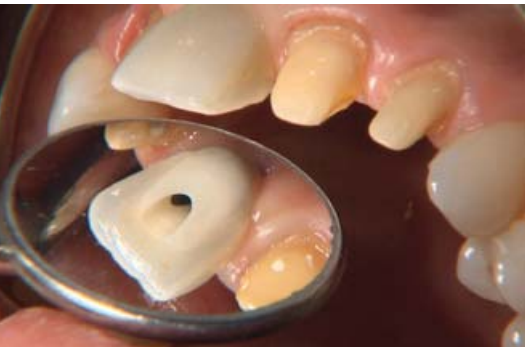

Fig. 39: The implant restoration is screw-retained. For biomechanical reasons, the screw access channel is placed in the zirconium oxide section.

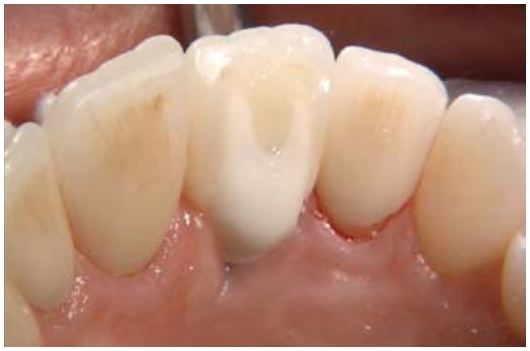

Fig. 40: The palatally inserted crowns and the sealed screw access channel of the implant crown.

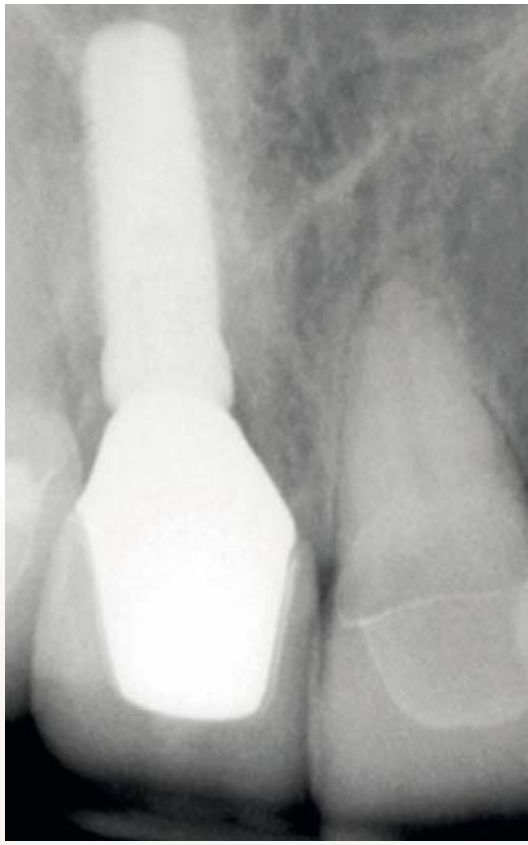

Fig. 41: The X-ray check-up confirms successful osseointegration and the natural emergence profile of the implant-supported restoration.

Fig. 44: The side profile also shows the natural contours of the restoration and the successful interplay between red and white.

Fig. 45: The patient's relaxed smile confirms that the effort and attention to detail have been appreciated.

The final X-ray confirms successful osseointegration of the implant and harmonious "emergence" of the implant-supported restoration from the bone **(Fig. 41)**. **Figures 42 to 45** show the esthetically successful outcome and a very satisfied patient.

Discussion

The example demonstrates the successful immediate implantation in the anterior maxilla on a female patient with thin biotype and high smile line. In addition, the buccal bone lamella was missing, so that bone and soft tissue had to be augmented as part of immediate implantation – without preparing a flap. This demanding task can only succeed when the surgeon, and, if applicable, the prosthodontist and the dental technician, work together as an optimal team and use suitable methods and materials. In the presented case, surgery and prosthetics were performed by the same dentist who has been working together intensively for many years with the dental technician in the same location. At the beginning of treatment, the patient presented in the laboratory for an esthetic analysis to give the dental technician a detailed picture.

In order to obtain adequate tissue volume in the implantation area, the surgeon employed proven bone and soft-tissue surgical procedures. These included using a bone mixture for augmentation and a tunnel technique for thickening the buccal soft tissue [10, 11]. The literature shows that stable tissue volume and a constant marginal soft-tissue border can be achieved in this way [5, 12] even in case of an impaired implantation site with missing bone lamella [8, 13]. This procedure is not (yet) recommended in the current consensus statements by the professional associations due to difficult predictability of individual results [14].

Analog and digital

A large part of treatment and the technical work steps were performed analog, in other words, with conventional surgical-prosthetic and craft-dominated technical dental methods. Computer-supported planning was not employed so that the surgeon was not guided but implanted freely in accordance with the surrounding structures. This requires a precise clinical and radiological analysis of the initial situation, appropriate planning and a high degree of expertise. Impression-taking also followed conventional techniques.

A speciality here is the use of a two-part hybrid abutment as base for the pressed ceramic veneer. To obtain a biochemically optimal titanium bonding base, a straight CONELOG® Esthomic abutment was customized in place of the alternatively available CAD/CAM component. The secondary zirconium oxide abutment was waxed up, then both components were scanned. This is where the CAD/CAM process came into play with the fine-tuning of the design on the screen and machine-fabrication of the zirconium oxide secondary abutment. Despite using a titanium primary abutment, the dental technician achieved a natural light effect by the consequent use of fluorescing materials.

As all components of the implant-supported restoration were bonded in the laboratory, the dentist was able to screw them in place together as a *single* piece and in a *single* session. This meant fewer treatment sessions for the patient, who did not have to return to the practice after impression-taking until final insertion. The esthetic try-in before final bonding of the individual parts was performed in the laboratory. The described procedure is only possible in close cooperation and with full confidence between the team partners.

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Experience this publication as a video! It comes from the video compendium "Implantatprothetik VIER TEAMS – IHRE KONZEPTE UND LÖSUNGEN" (Implant prosthetics FOUR TEAMS – THEIR CONCEPTS AND SOLUTIONS) (Quintessenz Verlag). Volume 2 by A. Happe and A. Nolte covers immediate implantation and full-ceramic restoration in the maxillary anterior region – an individual and interdisciplinary treatment concept. The video compendium is available from CAMLOG as a DVD or Blu-Ray disc.

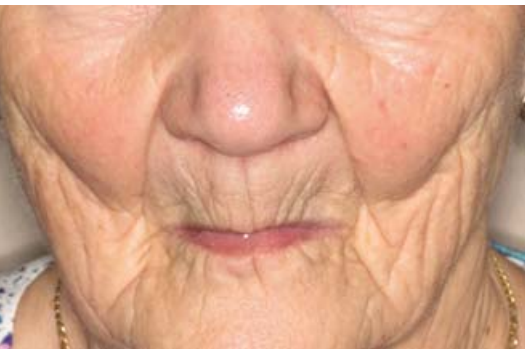


Fig. 1: Initial situation: the 76-year-old female patient shows the typical geriatric face when removing her dentures as a result of many years of wearing complete prostheses.

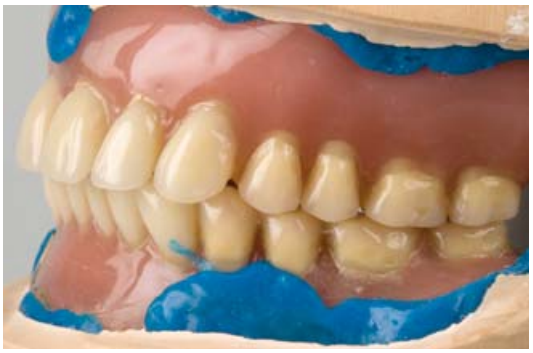


Fig. 2: The existing prostheses are used for functional impression-taking and the resulting models are then articulated.

Fig. 3: Bone resorption in the maxilla led to typical sagittal back-shift (pseudo-progenia).

LOCATOR®-RETAINED MANDIBULAR COMPLETE PROSTHESIS WITH THE ISY® IMPLANT SYSTEM IN A FEMALE PATIENT WITH EXTREME ALVEOLAR ATROPHY

Dr. Karl-Ludwig Ackermann, MDT Gerhard Neuendorff, MDT Christine Hammerl-Riempp, Filderstadt

The quality of life of persons with inadequately fitting mucosa-supported complete prostheses can be severely impaired. For example, they eat less often with friends as they have difficulty in chewing or are afraid that their dentures will become loose during talking or laughing [1]. For these reasons, implant-supported restorations have become established as first-line desired therapy and are also recommended by expert bodies [2, 3]. Not only do they improve function, esthetics and quality of life, they also reduce bone resorption, and as a rule, can maintain an adequate bone basis through to old age [4, 5]. However, many patients only have limited financial resources available, which do not allow elaborate restorations, for example, with bars or double crowns. Therefore, they should be offered more simple implant-supported options. An established option is a prosthesis retained with locators. This type of restoration is especially attractive with the new, extremely economical iSy® Implant System by CAMLOG. The component portfolio of the iSy Implant System is extremely reduced and simplifies processes in the dental office. It allows treatment of most standard and low-risk cases.

On behalf of the joint practice Drs. Kirsch & Ackermann, Dr. K.-L. Ackermann, MDT G. Neuendorff and MDT Ch. Hammerl-Riempp have prepared the following case study.

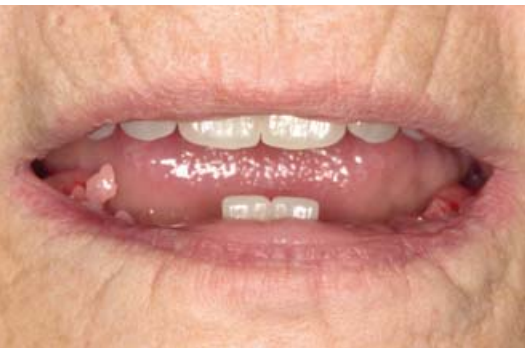
Initial findings and choice of therapy

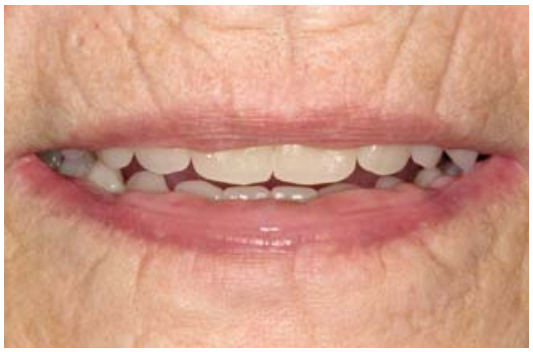
The 76-year-old female patient has been edentulous for over 20 years and wears purely mucosa-supported complete prostheses **(Figs. 1 and 2)**. As a consequence, the bone beds in both jaws have degenerated, resulting in pseudo-progenia with an extremely reduced volume of the alveolar ridge in the maxilla **(Fig. 3)**. The vertical distance is enlarged due to atrophy. The mandibular prosthesis in particular revealed a more than inadequate fit so that the patient decided on an implant-supported solution following extensive therapeutic consultation. The medical history gives no contraindications for implantation. Augmentation was not to be performed, on the one hand for cost reasons, on the other because the patient only wanted to undergo a *single* surgical intervention. No vestibuloplasty to improve or maintain the labial soft-tissue situation is planned for the same reasons. The unfavorable relationship of the jaws is to be compensated by vestibularly oriented placement of the implants **(see Fig. 7)**.

Also for reasons of easy handling, the prosthetic decision was taken in favor of a Locator®-retained prosthesis (LRP). Compared with fixed or other removable solutions, the prosthetic effort required is reduced considerably so that the cost element is reasonable. Furthermore, the necessary technical dental precision is easier to achieve with Locator® restorations than with bar constructions or the double crown technique. This objective can be achieved using an implant system which employs both reduced component numbers and easy work procedures. As the implantology team had no intention of sacrificing the quality of components, treatment was performed with the new transgingival iSy® Implant System by CAMLOG.

Preparative measures and preparation of the implant bed

The extremely atrophied bone base in the mandible **(see Figs. 10 and 11)** required very careful planning. This would be conducted with computer-supported systems in case of greater financial leeway. Without 3-D planning software, the necessary pre- and intra-operative information was to be obtained via laboratory techniques based on a functional and esthetic wax-up performed





Figs. 4 and 5: Together with the patient, the phonetic and esthetic aspects are modified until the patient regards the new esthetics and occlusal height as being comfortable.

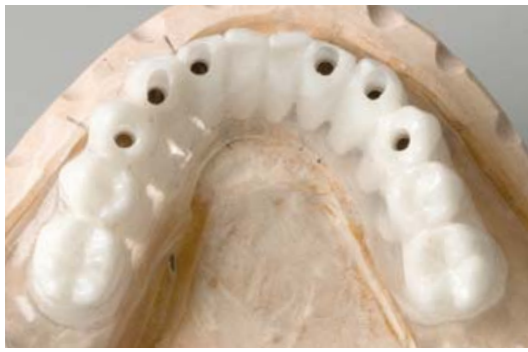


Fig. 6: With the aid of the wax-up, a transfer template is prepared from radiopaque (teeth with roots) and transparent plastic (base).

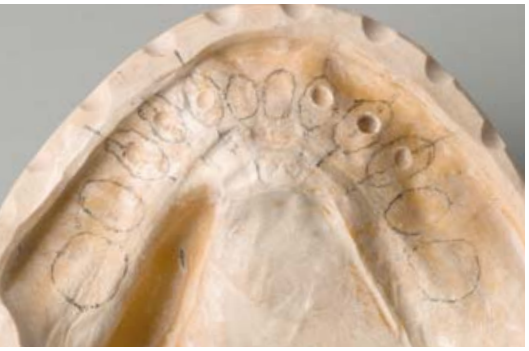


Fig. 7: The projection of the tooth roots is transferred to the model. Then, the optimal prosthetic implant positions are marked.

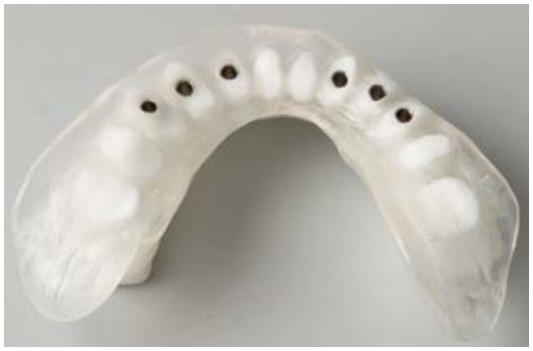


Fig. 8: The sleeves for marking the implant positions are polymerized for each tooth with the aid of the root projections.

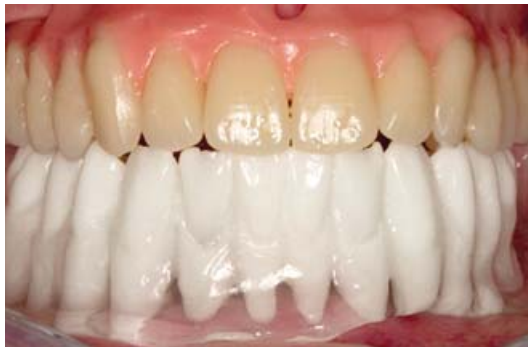


Fig. 9: Now, the drill template together with the wax-up of the maxilla can be tried in. Shape and alignment of the tooth roots largely correspond to those of natural teeth.

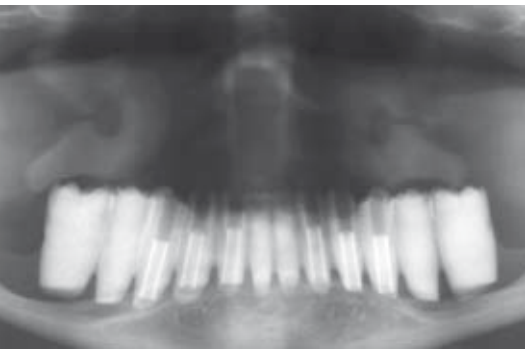


Fig. 10: The panoramic tomographic image shows the relationship of the drill sleeves to the anatomical structures in two dimensions.

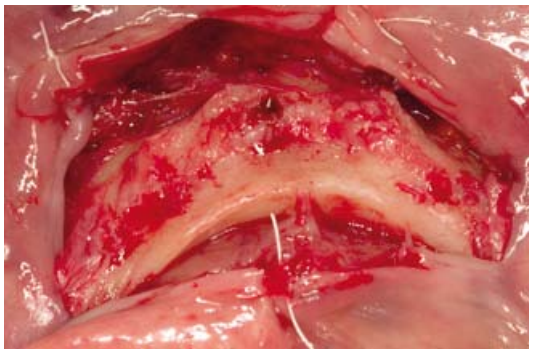


Fig. 11: A crestal incision is performed on the alveolar ridge to prepare the implant beds.

Fig. 12: The surgical prosthetic set can be autoclaved fully loaded, is logically designed and reduced to the essentials.

on the patient **(Figs. 4 and 5)**. In the end, this served as planning and transfer template. This corresponds absolutely to routine procedures with computer-supported planning. In order to preplan the implant positions as precisely as possible, the wax-up is transferred to a radiopaque plastic. The roots are created by grinding the plastic (following the tooth axis) to the alveolar ridge **(Figs. 6 to 8)**. The cavities between the roots and the template base are filled with transparent plastic. Finally, drill sleeves are polymerized taking the inclination of the teeth axes into account.

The X-ray template is used on the day of implantation and a panoramic radiograph performed instead of a 3D image **(Figs. 9 and 10)**. The image gives the surgeon fairly good orientation over two levels, and shows that four implants can be inserted in positions 34, 32, 42 und 44.

Figure 11 shows the intraoperative situation after exposure via crestal incision. The remaining anterior and posterior bone roughly corresponds to Cawood Class V [6], in other words, extreme atrophy of the alveolar ridge with sharp-edged crest.

The iSy surgical prosthetic set includes the specific surgical instruments required for implant bed preparation. It is of simple and logical design, can be autoclaved fully loaded, and is reduced to the essentials **(Fig. 12)**.

The X-ray template is converted into a transfer template by ablation of the teeth in the implantation area. The surgeon determines the position and axial direction of the implants via predrilling (drill with Ø 2 mm) through the drill sleeves **(Fig. 13)**. To facilitate subsequent placement of

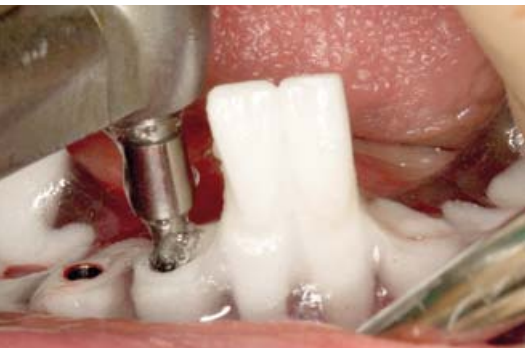


Fig. 13: Predrilling for preparation of the implant beds is performed with a 2 mm drill of the CAMLOG sleeve system.

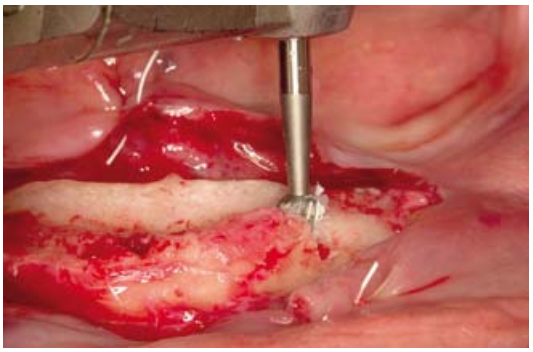


Fig. 14: After removal of the drill template, the implant positions are prepared for further preparation with the round bur Ø 3.5 mm.

Fig. 15: Pack contents of the iSy implant set: implant with implant base, healing cap, two multifunction caps, single-use form drill.

Fig. 19: The iSy implant set, the implant base (l.) with inserted healing cap (m.) and multifunction cap (r).

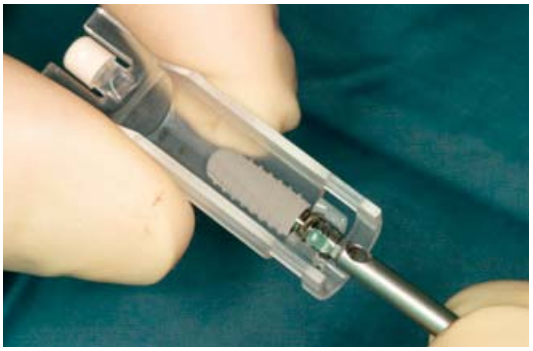


Fig. 20: The sterile packaged iSy implant (Ø 4.4 mm, length 11 mm) with pre-mounted implant base is removed directly using the long iSy implant driver …

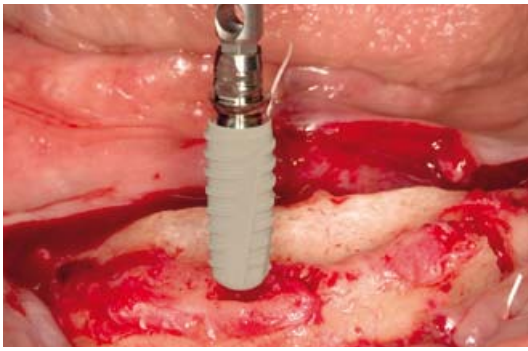


Fig. 21: … placed in the mouth …

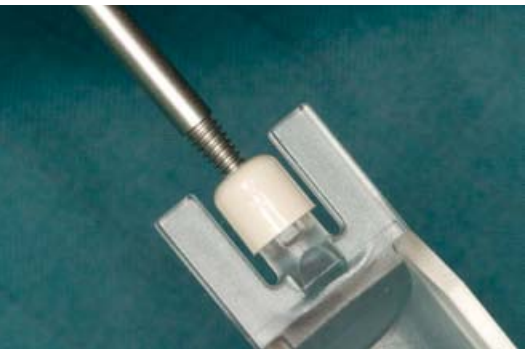


Fig. 24: The healing caps integrated in the implant packaging are removed with the iSy disconnector for healing caps …

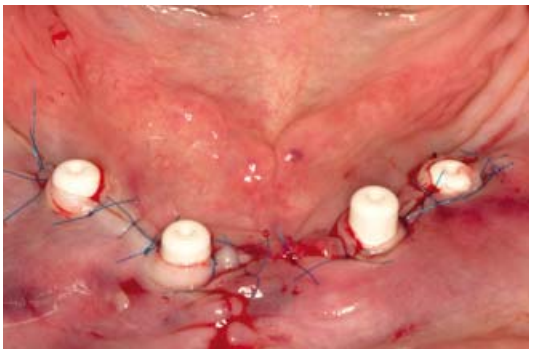


Fig. 25: … and placed over the snap mechanism on the pre-mounted implant bases: situation after double-layer suturing.

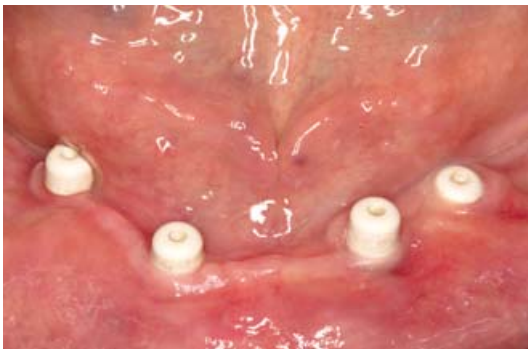


Fig. 26: The soft tissue around the healing caps has healed well also due to prosthetic abstention.

the Ø 2.8 mm iSy pilot drill, the predrilled hole is expanded with the round bur (Ø 3.5 mm) **(Fig. 14)**, whereby the sphere is sunk to the equator. Every iSy Implant Set includes a sterile single-use form drill **(Fig. 15)**. Pilot drilling follows pre-drilling and is drilled to the desired implant length. A directional and depth indicator is placed in the drill hole to provide orientation for subsequent form drilling **(Fig. 16)**. In this case study, the diameter of the central implants was 4.4 mm, that of the two distal implants 3.8 mm. Because of the relatively great diametrical difference between the pilot and the single-use form drill, preparation should be performed with only slight pressure, but "swiftly" and with ample cooling. To avoid compression stress to the cortical bone, a thread is cut prior to implantation in this case **(Figs. 17 and 18)**.

Implantation

iSy implants are supplied pre-mounted on an "implant base" and packaged sterile. The implant base is an insertion post, which at the same time acts as base for the healing cap, the temporary restoration, and the impression cap **(Fig. 19)**. To remove the implant, the iSy implant driver is fitted into the implant base **(Fig. 20)**, the ensemble placed directly in the oral cavity **(Fig. 21)**, and the implant screwed in manually as far as possible. Using the iSy Torque wrench, the implant is then driven into its final position **(Fig. 22 a)**. The transition from the micro-rough (Promote® plus) to the machined surface (front face of the implant) should be at bone level **(Fig. 22 b)**. The implant bases **(see Fig. 19)** remain in the implants until the Locator® abutments have been screwed and the insertion of the final work **(see Fig. 35)**. **Figure 23** shows all

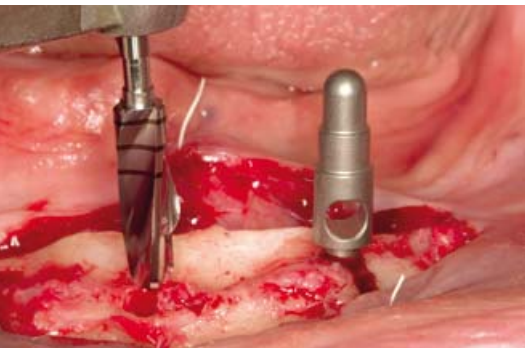


Fig. 16: After inserting the iSy directional and depth indicator in position 32, preparation of the implant bed in position 42 is completed with an iSy single-use form drill.

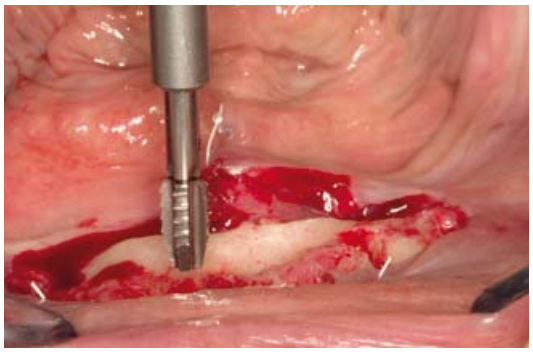


Fig. 17: An iSy thread cutter is used for the implant bed in position 32 …

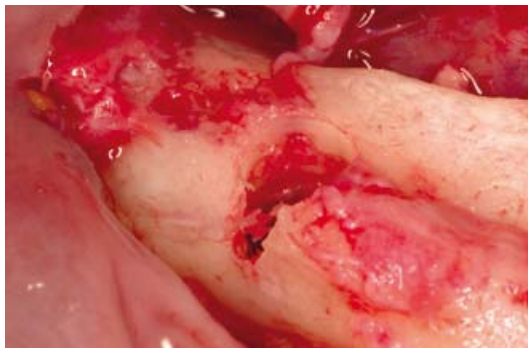


Fig. 18: … to prepare for implantation.

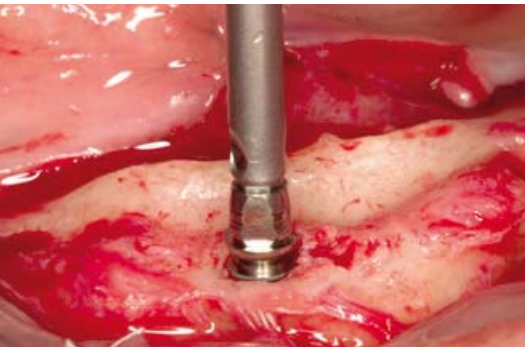


Fig. 22a: … and inserted in position 42 at bone level. The horizontal offset between implant shoulder and the pre-mounted base can be seen clearly.

Fig. 22b: Graphically illustrated precise epicrestal positioning of the implant shoulder.

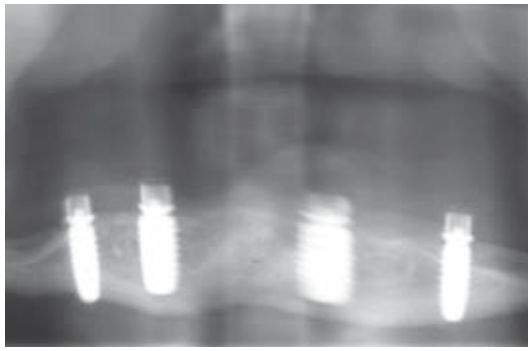


Fig. 23: The panoramic tomographic image reveals correct implant positions (distortion due to the patient moving).

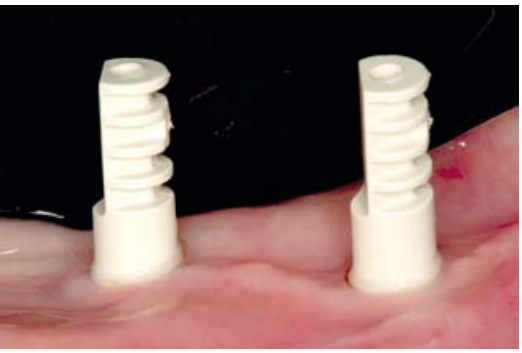


Fig. 27: The healing caps are removed and the supplied multifunction caps placed.

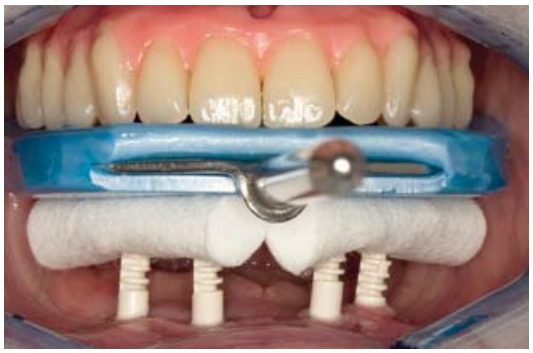


Fig. 28: Initially these serve to determine the jaw relationship with axis-adequate transfer of the maxillary position.

Fig. 29: The multifunction caps are suited for both analog or digital impression-taking. In this case, conventional impression-taking with a dual-phase polyether was performed.

four inserted implants in a panoramic tomographic image.

The iSy Implant System is intended for transgingival healing. For practical purposes, the healing caps are therefore included in the implant set **(Fig. 24)** and need not be ordered or stocked separately. The PEEK caps are inserted on the implant bases with a snap mechanism. Then the soft tissue can be sutured peri-implatarily and saliva-proof **(Fig. 25)** to ensure osseointegration and soft-tissue healing for the first 10 postoperative days. Then, the temporary prosthesis is placed "hollow" at the implant emergence sites and the entire base lined with permanent soft plastic in centric occlusion.

Impression-taking and finishing

This is reflected by good healing **(Fig. 26)**. After removing the healing caps, the iSy multifunction caps, which are also included in the system pack, are placed **(Fig. 27)**. First these are used to determine the jaw relationship **(Fig. 28)** and then for final impression-taking with polyether impression material **(Fig. 29)**. The implant bases are unscrewed in the same session and the gingiva heights of the Locator® abutments defined according to the mucosal thickness.

Then, the implant bases are screw-retained again in the patient with healing caps until insertion of the final restoration. In the laboratory, the laboratory bases are screwed together with the lab analog and placed in the multifunction caps, the master model is fabricated and articulated **(Fig. 30)**. Once the multifunction caps and the implant bases have been removed **(Figs. 31 and 32)**, the preselected Locator® abutments can be screwed in **(Fig. 33)**. The exact position of the

Fig. 30: The master model with multifunction caps placed on the implant base, …

Fig. 31: … after removal of the caps, …

Fig. 32: … after unscrewing the pre-mounted implant bases…

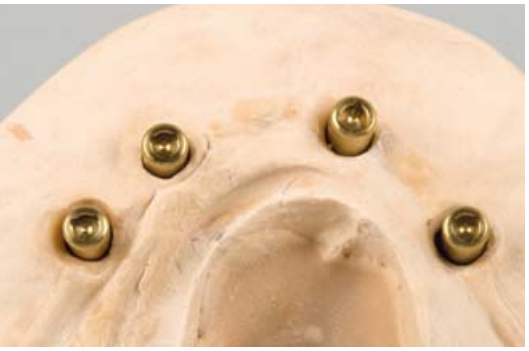


Fig. 33: … and after screw-retaining the Locator® abutments.

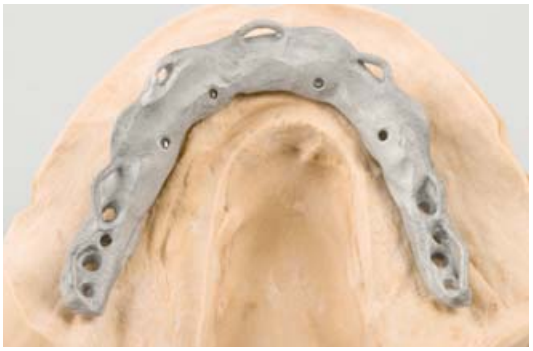


Fig. 34: The metal reinforcement cast in remanium.

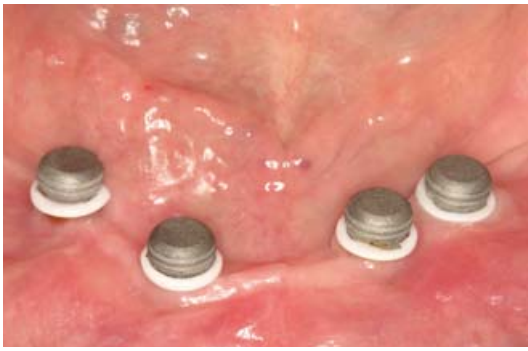


Fig. 35: In order to bond the Locator® housing in the mouth, the undercuts are sealed with white Locator® block-out spacers.

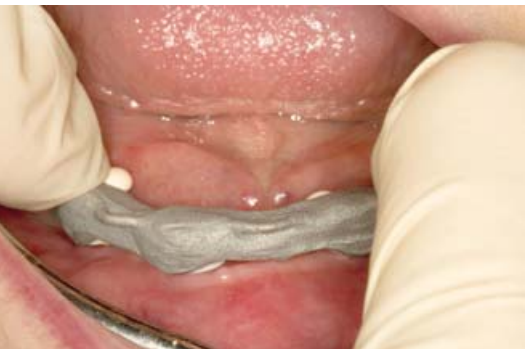


Fig. 36: The recesses for the Locator® abutments are filled with self-polymerizing plastic and placed over the matrices.

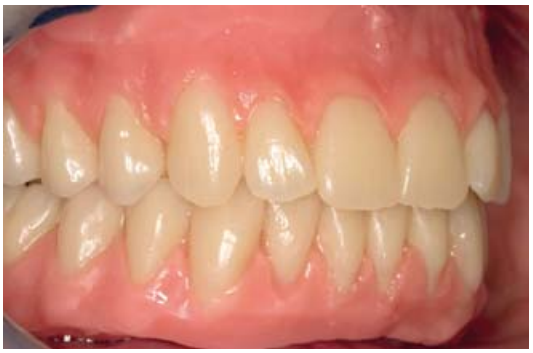


Abb. 37: The wax try-in.

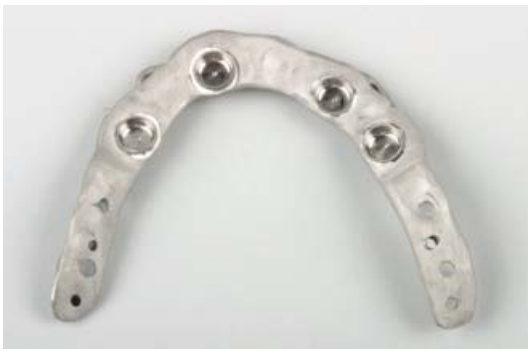


Fig. 38: The Locator® housings incorporated in the metal reinforcement.

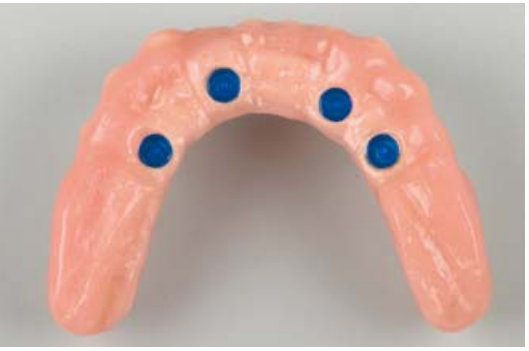


Fig. 39: The mandibular prosthesis from basal with blue Locator® retention inserts for easy removal of the denture from the mouth.

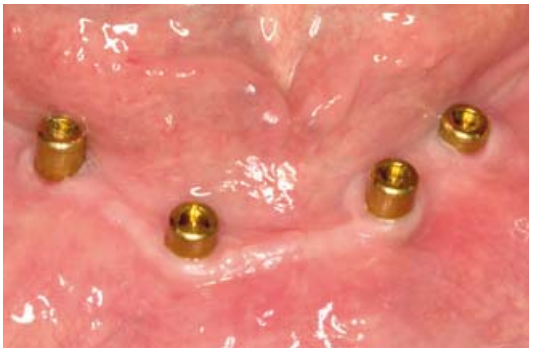


Fig. 40: The screwed-in Locator® abutments on the day of inserting the restoration. The locators in regio 44, 42 are GH 4 in regio 32, 34 GH 5 …

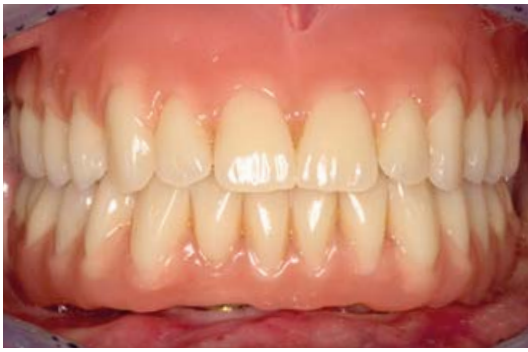


Fig. 41: … the inserted prostheses from the front …

Locator® retention range is 1.6 mm above the gingiva. The non-precious metal framework for the prosthesis base is fabricated over the inserted Locator® housings **(Fig. 34)**.

To obtain maximum precision and absence of tension, the Locator® housings are bonded to the framework in the mouth **(Figs. 35 and 36)**. Then a second wax try-in is performed on the metal framework to check esthetics and function. Only after this wax try-in **(Fig. 37)** are the mandibular **(Figs. 38 and 39)** and maxillary prostheses completed. **Figures 40** to **42** show the Locator® abutments and the inserted prostheses. The patient was very pleased with the esthetic and functional result **(Fig. 43)**.

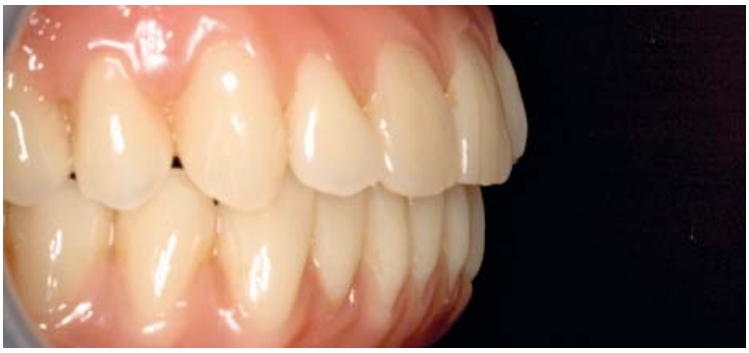


Fig. 42: … and right lateral, show harmonious positioning of the teeth.

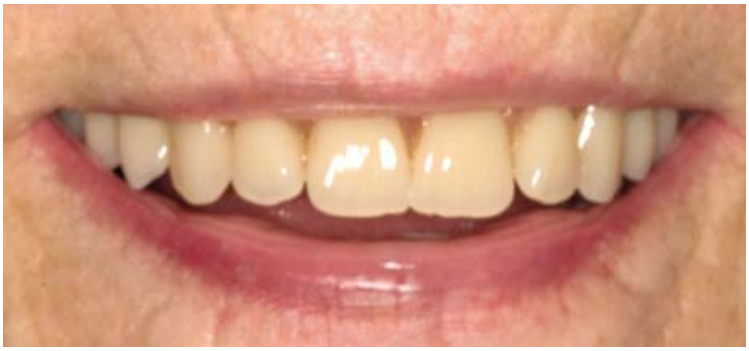


Fig. 43: The new Locator®-retained prosthesis is fitted stably, allowing the patient to chew well again, to talk without impediment, and to smile in a relaxed manner.

DISCUSSION

Patients at an advanced age benefit from implant-supported prosthetics in particular when they are edentulous. Chewing ability and other functional factors are improved significantly [7], and the associated self-confidence of the patients also increases their social well-being [1]. The lower follow-up costs of an implant-supported complete mandibular prosthesis put the initial additional costs into perspective when compared with purely mucosa-supported prostheses [2].

There are a number of established treatment options for implant-supported complete mandibular prostheses. If the choice is for removable solutions, then bars, double crowns or Locator® abutments are the most important connecting options [8]. As a rule, all three are successful [9, 10]. The choice depends on the jaw relationship, manual skills, as well as on the financial alternatives of the patient. In our patient case study, all factors were in favor of the relatively easy to realize Locator® System.

An Intelligent System

For economic reasons, we selected the newly available iSy® Implant System by CAMLOG for our patient. iSy stands for "intelligent system", which highlights its most important feature: highly efficient use, due to an extremely lean system of components. This already includes a pre-mounted temporary abutment ("implant base"), which in our case was replaced with Locators for the final restoration. The healing phase is transgingival as a matter of principle, and the healing caps are included in the set. This reduces the time required for changing components and also reduces surgical effort for exposure **(see also Fig. 15)**. In this patient case study, we did not perform vestibuloplasty, despite extreme atrophy of the bone and correspondingly reduced attached soft tissue.

The simplified surgical protocol was only possible with very careful planning, which was performed with the aid of a radiopaque transfer template and a panoramic tomographic image. Computer-supported planning in conjunction with a DVT or CT, which is used normally, was again dispensed with for reasons of cost. Depending on the initial situation and clinical experience, the treating team could also have decided otherwise.

Preparation of the implant beds is also simplified with iSy as the implant set includes a single-use form drill. The iSy surgical prosthetic set is simple, well thought-out and of logical design, can be autoclaved fully loaded and is reduced to the essentials **(see also Fig. 12)**. Cutting of a thread is essential in dense or pronounced cortical bone as was the case for this patient.

iSy implants are fitted with a conical internal connection with a hexagon to avoid rotation. Due to the micro-rough surface (Promote® plus) reaching to the shoulder, placement at bone level is recommended. Accordingly, the prosthetic and technical handling of the system differs, especially when compared with the

CAMLOG® Implant System and its familiar cam-groove connection. This offers major advantages in complex restorations or difficult soft-tissue conditions. The iSy implant-abutment connection with its simpler "inner workings" is sufficiently precise and good to work with in standardized prosthetic treatment concepts, such as a Locator® restorations, but also individual tooth reconstructions in conjunction with digital processes, for example, with DEDICAM, the CAD/CAM prosthetics by CAMLOG. The overall iSy concept reduces costs for the patient, a prerequisite for treating the patient in this instance. For us, this is the central aspect for the indication of the iSy Implant System.

Conclusion

This case study demonstrates how patients with poorly fitting mucosa-supported complete prostheses can be successfully and economically rehabilitated with the aid of implants. Owing to the limited budget of the patient, the selected restoration with the new iSy Implant System represented an optimal solution.

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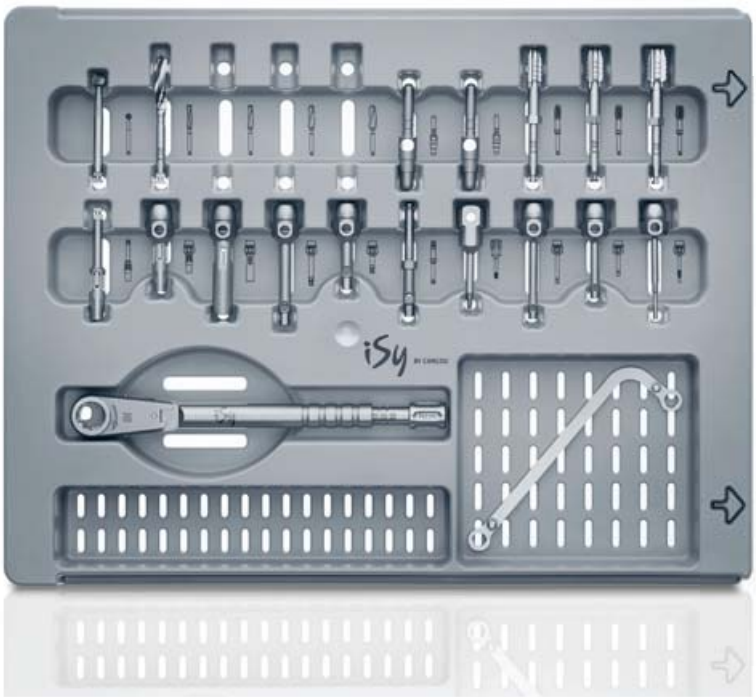

iSy by CAMLOG breaks new ground and adds dynamics to the implant market

Only a few weeks after its debut on the German market, CAMLOG launches its new implant brand, iSy, in other countries. The new, radically down-sized implant system was first presented in March 2013 at the IDS trade show. iSy has attracted considerable attention from dentists and oral surgeons right from the start: several thousand iSy implants have already been sold in Germany within the first two months. Due to high demand from other European markets, CAMLOG has now brought the launch of the new brand forward in other countries.

German and international implant market grow closer

A special focus on international markets was already taken into consideration in the development of iSy by CAMLOG. Same as in Germany, the value segment is playing an increasingly important role, internationally. iSy by CAMLOG offers practitioners in these markets a number of benefits next to an attractive price-performance ratio: the high level of standardization within the system and the single-use instruments offer security together with a high quality standard in treatment.

Unusual IDS appearance created high awareness

Innovative communication fitted the novel concept presented in Cologne: the iSy exhibition stand was certainly one of the most eye-catching appearances at the IDS as was the gigantic, free-standing poster outside the exhibition halls. With emotional images and fresh colors, iSy has also been following new avenues in communication.

Breaking new ground

iSy by CAMLOG is precisely positioned to fill the gap between premium implant brands and the discount brands, where many dentists have doubts about their reliability. Michael Ludwig, Managing Director of CAMLOG Vertriebs GmbH, Wimsheim, states: "With iSy, we at CAMLOG have given an innovative answer to the impending changes on the implant market. Our full focus, from development to sales, is based on competencies we have built ourselves. With iSy, our customers receive proven quality made in Germany. The system is designed to give users the highest possible level of transparency and efficiency. With iSy, we have entered new territory in implant dentistry."

Well-conceived in every detail

iSy stands for "intelligent System" and with just 70 components, it is extremely lean and allows treatment of most standard and low-risk cases. Even esthetically demanding solutions can be realized thanks to the integration of DEDICAM® CAD/CAM prosthetics by CAMLOG. The concept also includes simplification of the processes in the practice – from placing the implant to order and parts management to continuing education and training. Online ordering options, e-learning offers and the possibility of multimedia communication with the dental laboratory allow optimal integration of iSy into the digital workflow of the dental office. iSy is the perfect combination of digitalization and conventional processes for dental office.

Starting to digitalize their processes. The high degree of standardization of all system components makes it possible for CAMLOG to offer iSy at a very attractive price without compromising quality. The products are manufactured by CAMLOG in Wimsheim, Germany.

VALENCIA – PALAU DE LES ARTS – CITY OF THE ARTS AND SCIENCES

The city of Valencia is located some 320 km south-east of the capital Madrid in the estuary of the river Turia into the Mediterranean Sea, and is Spain's third largest city with a population of approx. 795,000. Considerable urban development took place over the last few decades and has made Valencia an attractive place for tourists. This includes the restoration of the historic center and the building of modern administration offices and museums. A modern marina was constructed for the Americs's Cup held in 2007 and 2010. And not to forget, the Formula 1 race track, the "Valencia Street Circuit", which was constructed in 2008.

A tour through Valencia's historic center is more than rewarding. In particular, the Silk Exchange is worth visiting (Lonja de la Seda). Erected between 1482 und 1533 under supervision of the master stone mason Pere Compte. It is regarded as being one of the most significant buildings of profane Gothic in Europe. Since 1996, the Lonja de la Seda is part of the UNESCO world heritage. Another attraction is Valencia's cathedral, which was erected in 1262 on the foundations of an old mosque. Different architectural styles make this building rather special. The Gothic tower, *Torre del Miguelete*, added to the cathedral in the 14th century, is regarded as the city's landmark.

But the sights in the historic center of Valencia are not the only attractions for visitors. Small shops offer curiosities and unusual fashion. Numerous bars encourage keen dancers to indulge till the early morning hours.

A visit to the Mercato Central is definitely an experience. It was built in 1920 and is one of Europe's largest markets at 8,000 sqm and nearly 1,000 market stalls. The building with its Art Nouveau architecture is certainly worth a visit. The conspicuous roof consists of inventive cupolas and slanted, inserted roofs at several levels, while the interior is lined with different materials such as metal, wood, ceramic and colored tiles. The beauty of the complex is highlighted by daylight entering through various skylights and stained windows. Some 15,000 customers find their food from the region of Valencia here every day, from ham and cheese to fish and shrimps, fruit and vegetables.

Skyline of Valencia

The CAMLOG Congress location 2014: Palau de les Arts

The architect, engineer and artist, Santiago Calatrava, was born in 1951 near Valencia. He was already instructed in drawing and painting as a child. He started studying at the École des Beaux-Arts in Paris and later enrolled at the Escuela Técnica Superior de Arquitectura in Valencia. In addition to studying architecture, he also took courses in urban development. Attracted by the mathematical strictness which he observed in certain works of historical architecture, and the feeling that his studies in Valencia had not given him any firm direction, he then enrolled for further studies in structural engineering at the ETH in Zurich. Calatrava's early interest in art and his esthetic flair proved to be consistent features of his work and have made him a prominent figure in temporary architecture.

The Ciudad de las Artes y de las Ciencias – the city of art and science – was designed by Calatrava. However, it took over ten years to be completed. It is a complex of futuristic buildings, unique in style, and now one of Valencia's main tourist attractions. As part of the restored eastern border of the city, it is located in what used to be the Turia's river bed, converted into a wonderful park landscape with recreational, cultural and sports activities. It also includes the Planetarium and an IMAX cinema with eye-shaped layout as well as the science museum, Príncipe Felipe. The Palau de les Arts (opera house) completes this ambitious project. The 5th international CAMLOG Congress will be held in this architectural highlight from 26th to 28th June 2014, and you are already cordially invited.

Other interesting architectural works of art of this architect include the airport Sondica in Bilbao, the auditorium in Santa Cruz de Tenerife, Milwaukee Art Museum (Wisconsin), the pedestrian bridge Puente de la Mujer (Buenos Aires), Turning Torso (Malmø), the Olympic sports complex (Athens), to mention but a few.

Sources: www.wikipedia.org, www.spanien-heute.de, Philip Jodidio: Calatrava, Taschenverlag