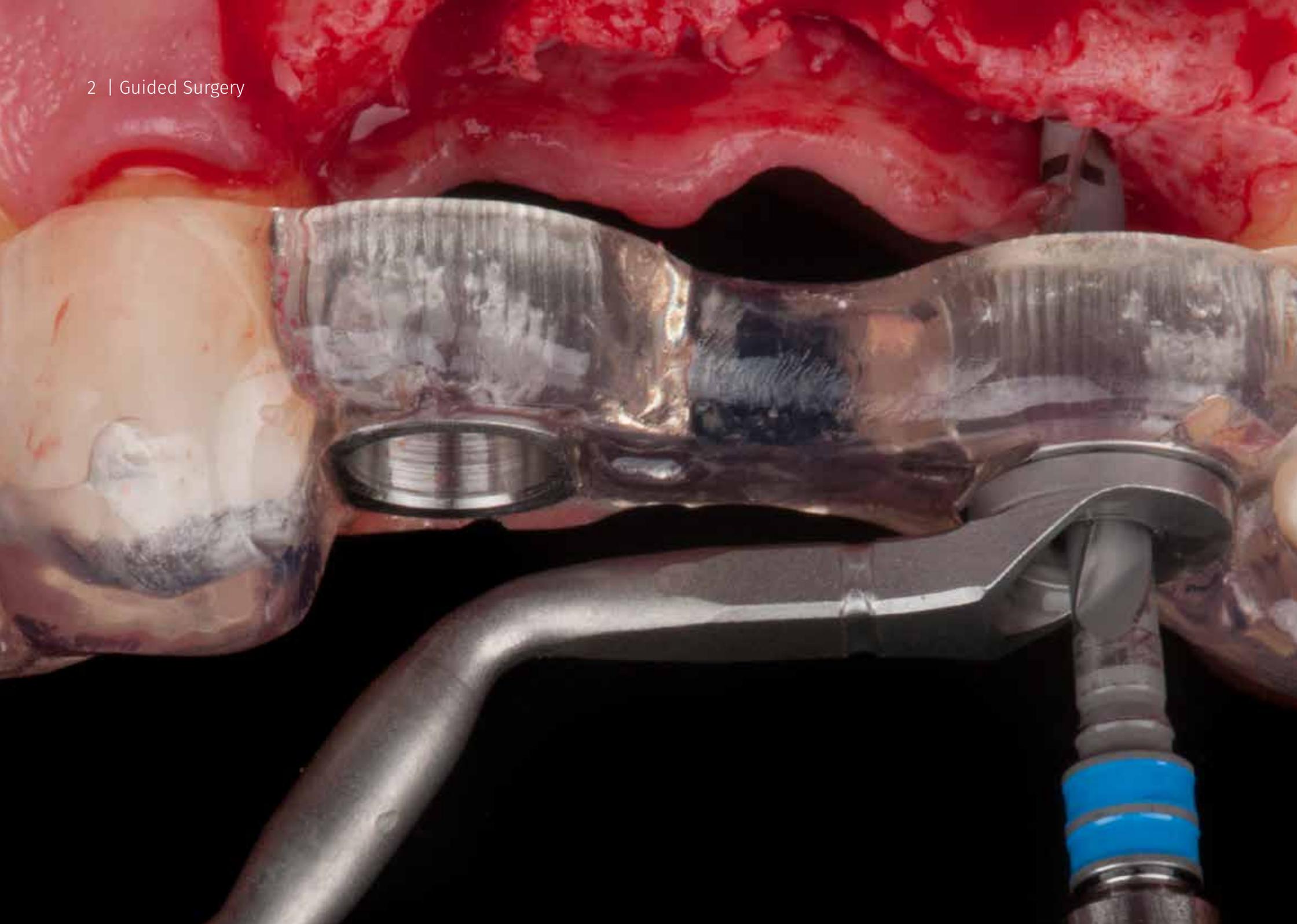


THE ESSENCE COLLECTION



GUIDED SURGERY

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Maja Chmielewska, DDS





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Preface

As an implantologist with over 25 years of experience, I have always been devoted to mine Patients. They deserve the best treatment quality with the highest predictability, precision and medical standards. Implant planning is a key element in achieving a predictable treatment result and patient satisfaction.

The correct placement of the implant is determined by a prosthetic restoration. The dentist must therefore make the right plan and use the right tools to transfer this position to the patient's mouth in accordance with the planned crown, bridge or other complex reconstruction. Treatments performed with the help of computer navigation become the gold standard. Thanks to this technology, the dentist can place the implant with the highest precision. However, new technologies require time and commitment to get to know them and implement them successfully.

This guide was created in response to the needs of doctors who expect support in the planning of implant treatment and learn about the techniques and tools used to carry out the treatment using guided surgery templates.

Now, with my Team, I can help my Colleagues, offering them services of remote planning and printing of the highest quality templates for computer navigation.

We are giving you this guide, created to help you in the smooth implementation of computer navigation to your practice.

Have a good read,

A handwritten signature in black ink, appearing to read 'Krzysztof'.

Krzysztof Chmielewski, DDS, MSC
Master of Science in Oral Implantology
ITI Fellow



Guided surgery requires not only surgical skills but also knowledge about the technology, software application and crucial steps influencing the precision of the surgical treatment.
Implementation of digital protocols can be easier than you think.

Maja Chmielewska, DDS
ITI Member



Introduction

Nowadays, patients expect both a short treatment time and beautiful aesthetic results. The integrated workflow, helps clinicians and technicians to go to the planning of implants based on the optimal position of prosthetic restoration, while allowing delivery of the temporary restorations that meet the patient's expectations for a beautiful smile immediately after the surgery.

Knowledge of the process, tools and technologies associated with the design of a computer navigation template is necessary to achieve high predictability and precision in guided surgery.

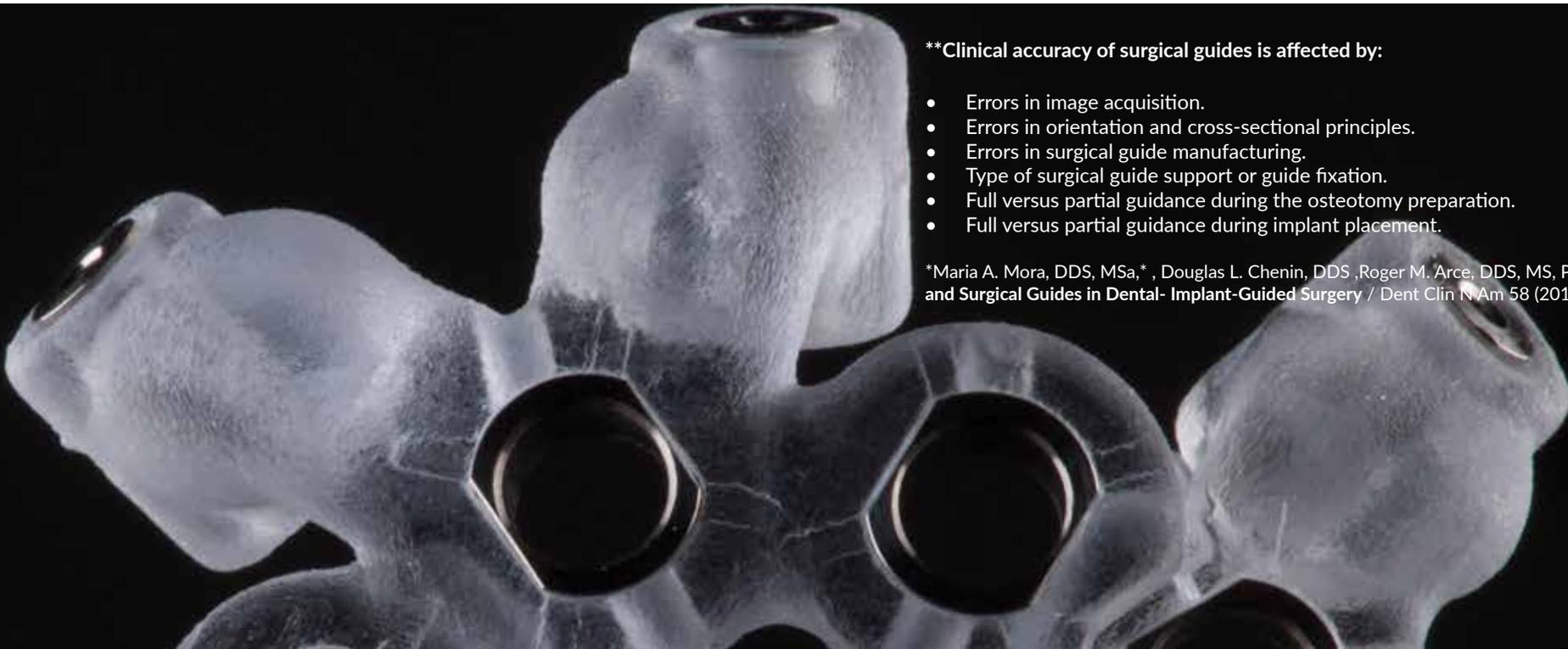
***Computer-guided surgery was more accurate than a freehand approach for placing implants into bilateral edentulous zones in the posterior maxilla.**

*Noharet R, Pettersson A, Bourgeois D. Accuracy of implant placement in the posterior maxilla as related to 2 types of surgical guides: a pilot study in the human cadaver. J Prosthet Dent. 2014 Sep;112(3):526-32.

****Clinical accuracy of surgical guides is affected by:**

- Errors in image acquisition.
- Errors in orientation and cross-sectional principles.
- Errors in surgical guide manufacturing.
- Type of surgical guide support or guide fixation.
- Full versus partial guidance during the osteotomy preparation.
- Full versus partial guidance during implant placement.

Maria A. Mora, DDS, MSa, , Douglas L. Chenin, DDS ,Roger M. Arce, DDS, MS, PhD / **Software Tools and Surgical Guides in Dental- Implant-Guided Surgery** / Dent Clin N Am 58 (2014) 597–626



REASONS WHY YOU SHOULD OFFER GUIDED SURGERY:

BENEFITS FOR PATIENTS

Safety

- Optimal positioning of implants at safe distances from important anatomical structures such as vessels, nerves or maxillary sinuses.
- Safe conducting of flapless procedures.

Comfort

- Reducing the time of surgery.
- Smaller postoperative reactions.
- Often no pain after surgery.
- Comfort of treatment through the use of precise temporary restorations screwed to the implants immediately after the procedure.

Financial benefits

- Optimization of costs by reducing the number and duration of visits.
- Reduce treatment costs by reducing the number of augmentation procedures.
- Optimal selection of prosthetic elements at the planning stage.

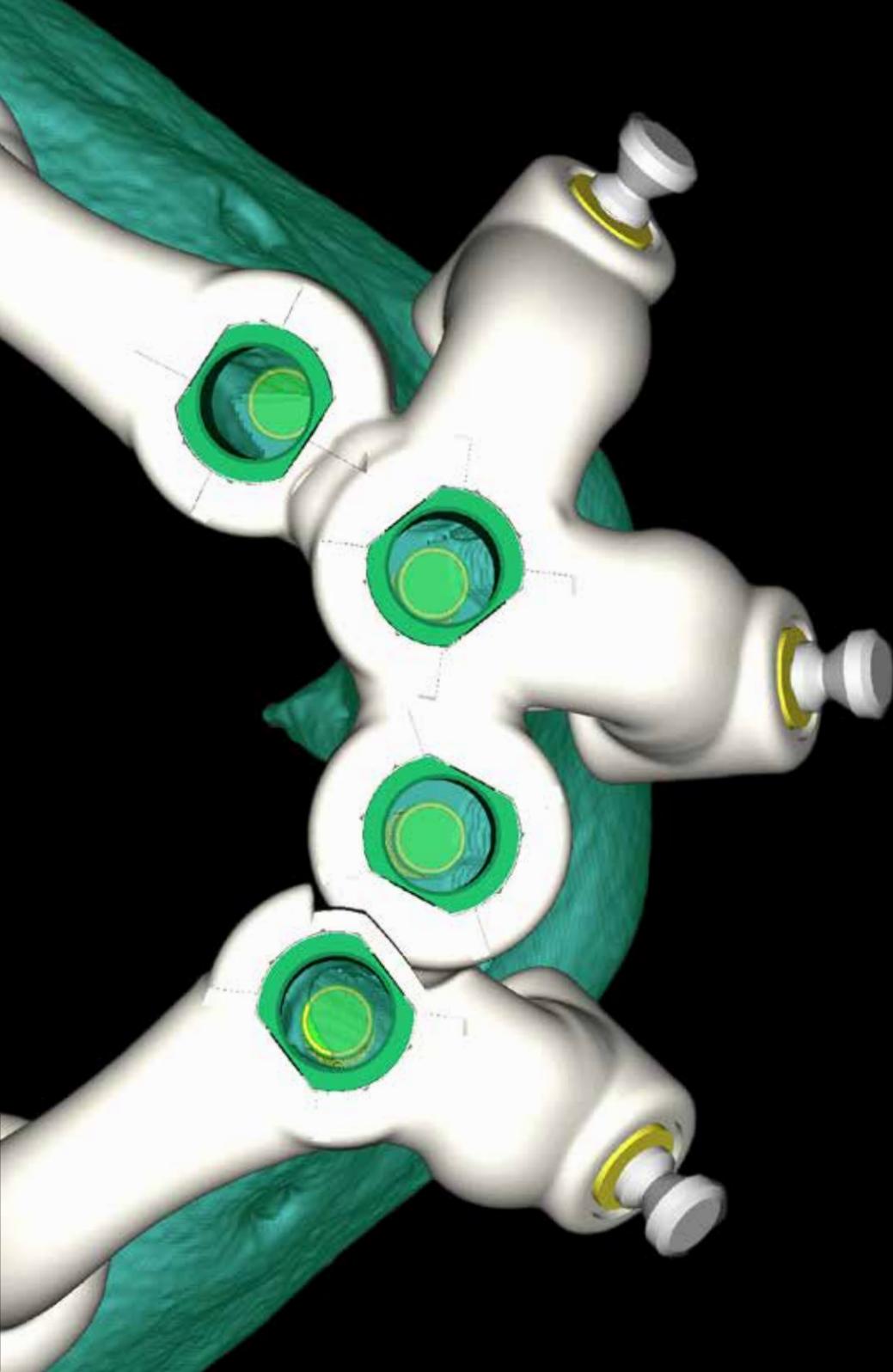
BENEFITS FOR DOCTORS

Safety and comfort of treatments

- Optimal planning of implant positions due to anatomical structures and bone quality.
- Reducing the number of complications.
- Reducing the time of surgery.
- The ability to safely conduct flapless procedures.
- Predictable procedures with immediate implant loading.

Financial and marketing benefits for the Doctor

- Optimization of visit duration. It is possible to carry out more treatments at the same time.
- Optimization of the costs of prosthetic elements by reducing the number of angulated or individual abutments.
- Better communication with the Patient and building trust through the application of modern technologies.
- Distinguishing factor from the competition.



Workflow

Brief Introduction

Preparation for guided surgery requires the collection of information on hard and soft tissue in the oral cavity. We collect this data by performing a computed tomography scan, taking impressions and/or scanning the tissue within the oral cavity using intraoral scanners (IOS). Scanning of the analog models supplements the digital workflow.

Thanks to dedicated software, we combine images from the CBCT study together with a digital image of teeth and gums, which allows for very precise planning of the implant's position relative to the planned prosthetic restoration and neighboring teeth and anatomical structures.

Transfer of the planned implant position to the oral cavity is carried out using a computer navigation template. The design is carried out in the same dedicated software. There are many types of templates and each of them is designed for the needs of an individual patient. They can be milled or printed. Before the surgery, the template is disinfected or sterilized in a suitable process. During the procedure, the surgeon prepares the implant bed using the template as a guide for the drills, thus obtaining the axis, inclination and depth of the implant preparation as planned. In the most advanced systems, the implant is also inserted via the template to obtain the most optimal position.



COOPERATION

Cooperation between the Clinician and Printing Center in 5 steps.

START

01

Step 01 - Clinic:
Impressions and
bite registration

02

Step 02 - Dental Print 3D:
Plannig of the implants posi-
tions and designing the
surgical guide

03

Step 03 -Clinic:
Plannig aproval

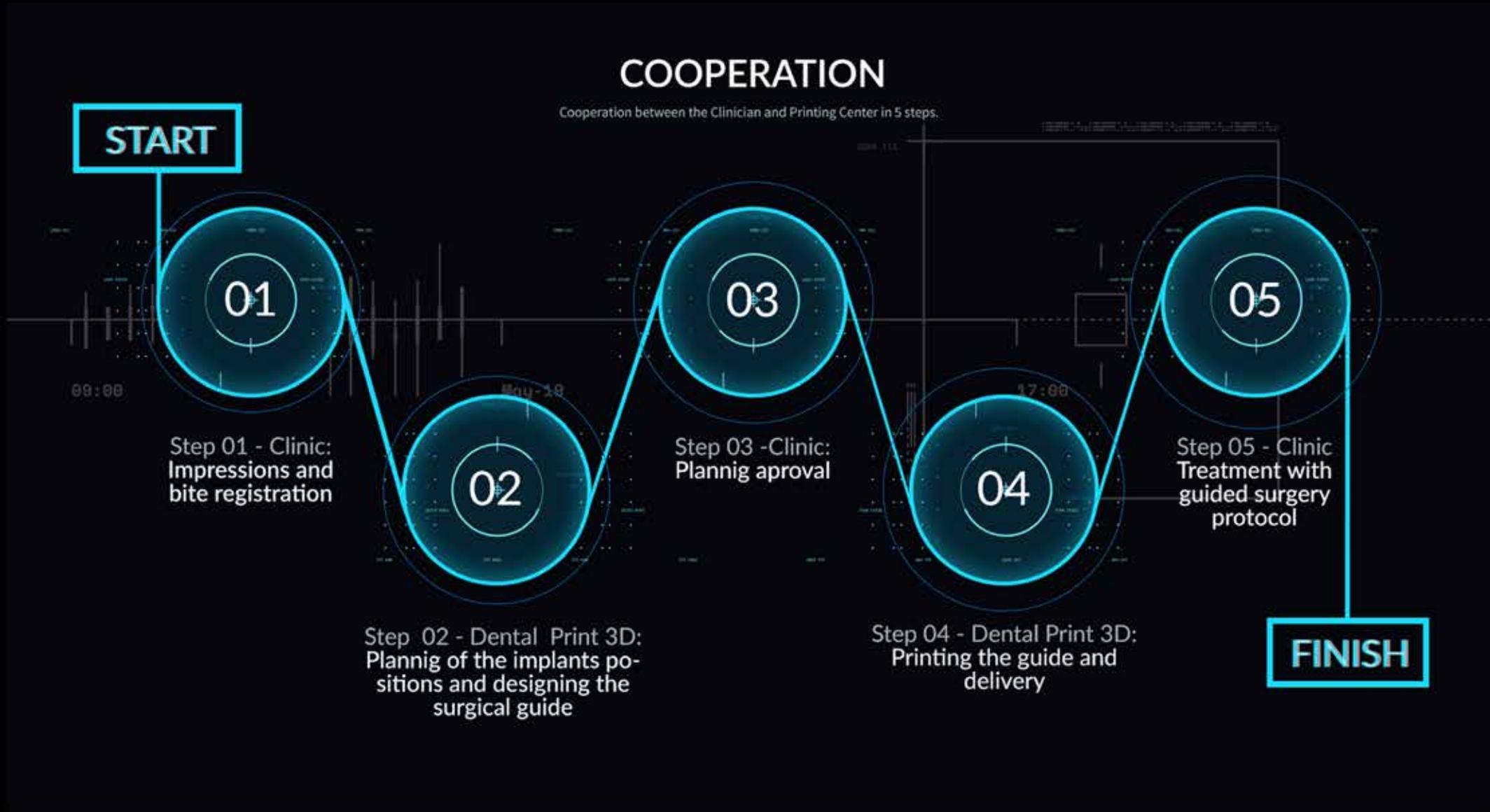
04

Step 04 - Dental Print 3D:
Printing the guide and
delivery

05

Step 05 - Clinic
Treatment with
guided surgery
protocol

FINISH



CT/CBCT



Introduction

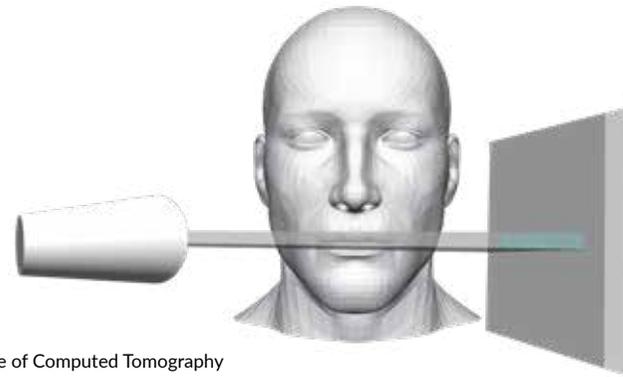
To understand CBCT, it is important to understand how CT works in the first place.

Unlike 2D radiographic imaging, in Computed Tomography (CT) the detector does not produce an image. Instead, the detector records transmission of a beam of x-rays through the body, at different angles, and complicated computer algorithms reconstruct images from the data recorded. Among the data extracted from the recordings we gain cross-sectional views, 3D reconstructions etc.

The x-ray source and detector move around the patient, in opposite directions. This means that the image blurring occurs away from the recorded slice. Diffuse radiation does not affect image quality too much due to thin slices recorded in every take.

Classical tomography moved only up and down the patient. In one row computed tomography (CT), the lamp (x-ray source) and one detector move around the patient, while recording one slice of the examination. Then the table with the patient slides in the apparatus, and another slice is recorded. The examinations took a long time and the technology advancements allowed for the development of Multi-Detector Computed Tomography, MDCT and Spiral CT. Nowadays, the CT scanners have 512 or 256 detectors opposing the lamp, which allows for much quicker examinations. Spiral CT, as compared to CT means, that the table with the patient constantly moves through the apparatus, increasing the speed of the examination furthermore. The lamp is constantly emitting radiation, as compared to turn-stop-slide-turn-stop protocol in basic CT machines. The technology most up-to-date in CT scanning is multi row spiral computed tomography, which merges the cons of each of the developments described.

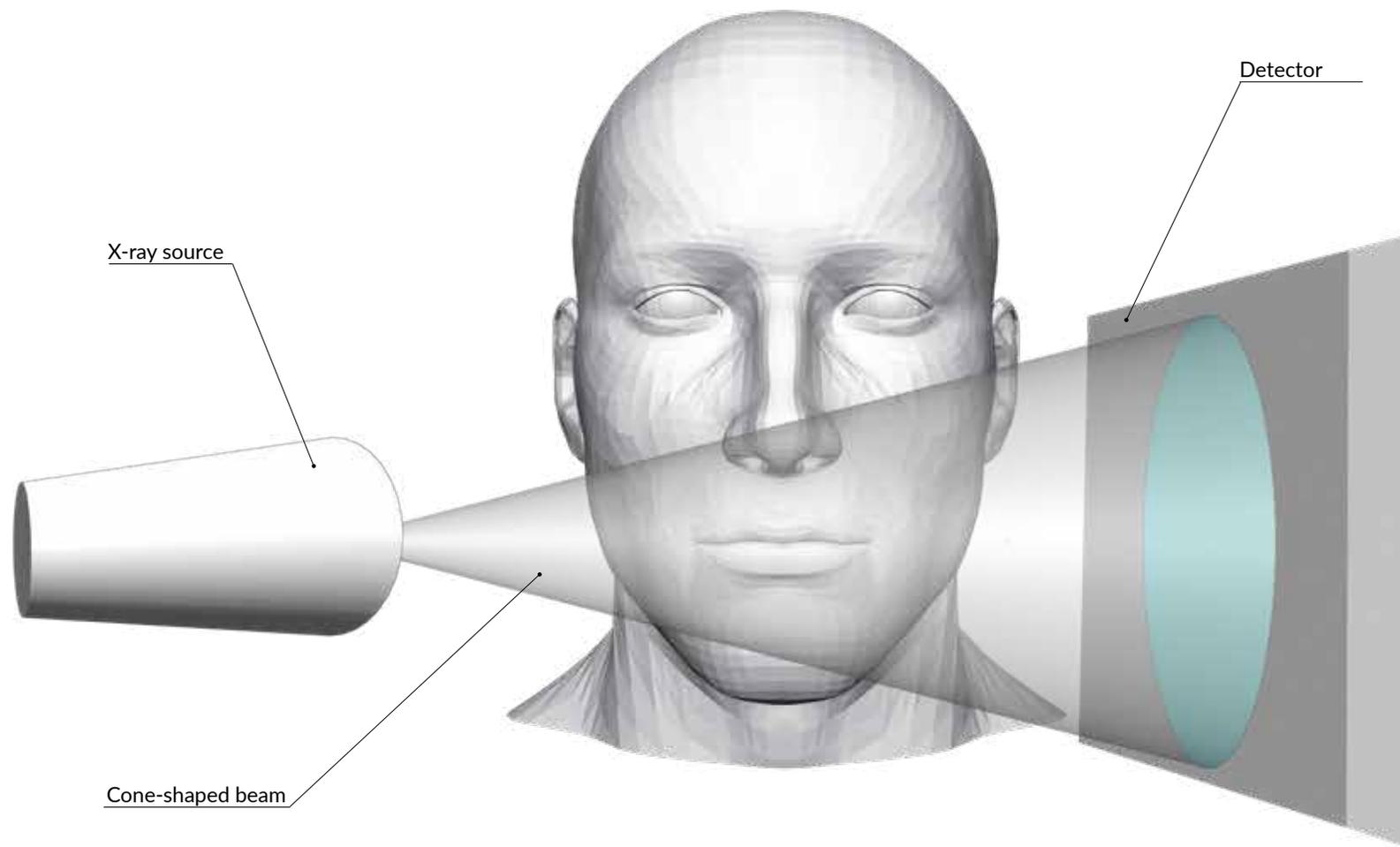
The part of the CT apparatus, supporting the source of radiation and the detectors is called the gantry. **Gantry angle** is the angle at which the gantry of the apparatus is set during the examination. This however applies to CT scanners and in case of CBCT - gantry angle messages visible in planning softwares can be skipped most of the time.



The principle of Computed Tomography

The development of **CBCT** (Cone Beam Computed Tomography) was possible only about 20 years later than CT, due to available detector sizes. Cone-shaped beam and detector size allow for much faster scanning, with higher image spatial resolution and lower radiation doses for the patient. The same beam shape and detector size however, have their cons. Measuring of Hounsfield Units is not applicable on CBCT due to diffuse radiation.

Hounsfield Units (HU) – in short, Godfrey Hounsfield created a scale to most precisely assess the tissues we look at in the CT imaging. The scale is based on the measured attenuation coefficient changes in tissues, as compared to water. Hounsfield referred to the water as the 0 value. Any tissue attenuating x-rays less than water is described in negative values within the scale, with fat between -60 and -120 HU and air being -1000 HU. Any tissue denser than water is described in positive values, with compact bone defined as +1000 HU. Hounsfield Scale enables us to measure bone density on computed tomography imaging. The scale, however, does not work for CBCT and is not applicable therein. The reason behind this is the diffused radiation, which is also recorded on the matrix during a CBCT scan. In such conditions, water can no longer be measured as “0”, as diffused radiation blurs the readouts. The reference system is lost, and different scans are not comparable. Experienced clinicians can more or less assess which bone-type they will be dealing with, provided that the CBCT apparatus settings are constant for their patients in all compared cases and, that the DICOM data come from the very same machine. Otherwise, the assumptions are approximations too vast, to lead to predictable results.



The principle of Cone Beam Computed Tomography

CBCT

What is CT Scan?

*A CT scan, also known as computed tomography scan, makes use of computer-processed combinations of many X-ray measurements taken from different angles to produce cross-sectional (tomographic) images (virtual “slices”) of specific areas of a scanned object, allowing the user to see inside the object without cutting. (*Wikipedia)

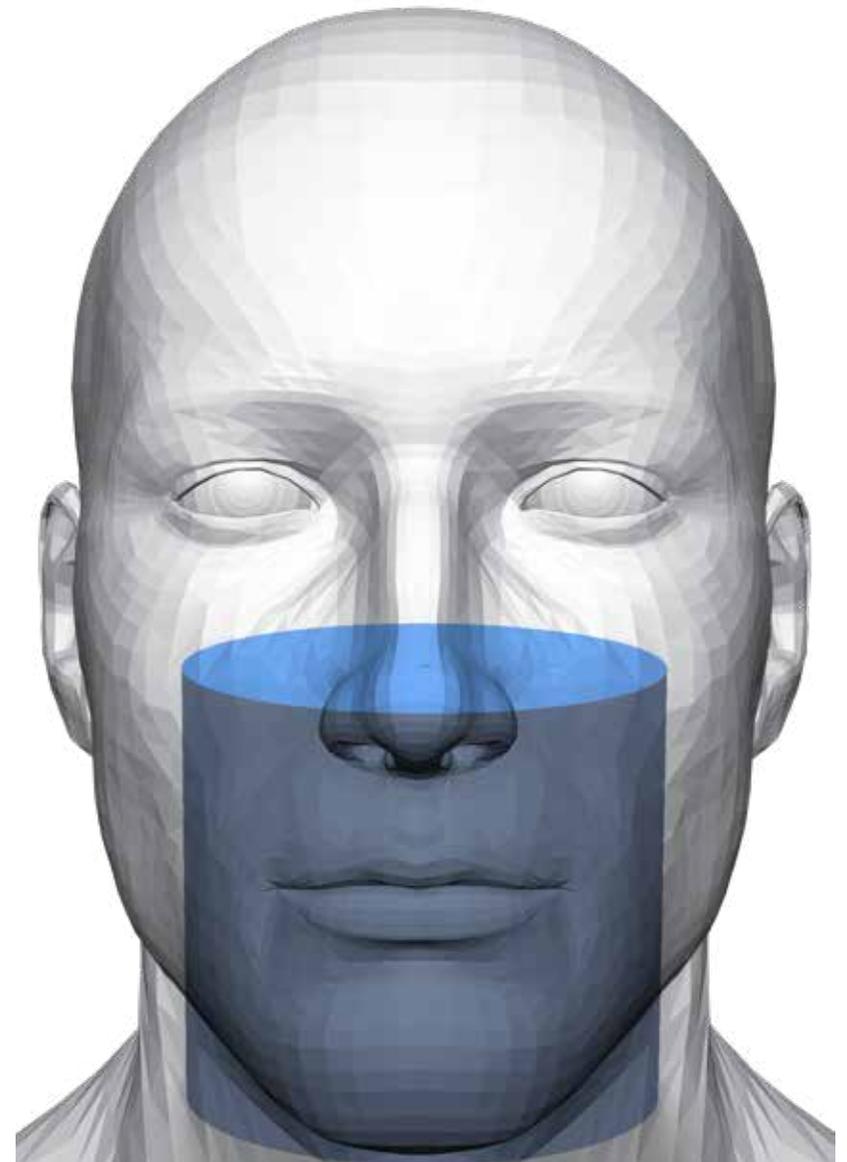
What is CBCT?

Computed tomography (CBCT) is a medical imaging technique consisting of X-ray computed tomography, in which X-rays are divergent, forming a cone. CBCT uses pyramid or cone-shaped X-rays and an area detector that obtains the full volume of images in one rotary motion.

Field of View (FOV)

There are many CBCT equipment manufacturers and many models are available. In general, CBCT is divided into large, medium and small units based on the size of their “imaging field”. The size of the FOV describes the scan volume of CBCT machines. This volume determines the extent of the anatomy. This depends on the size and shape of the detector, the geometry of the beam projection and the ability to collate the beam. The FOV should only slightly exceed the anatomical area that is at the center of our interest.

For implantological procedures in computer navigation, an imaging field covering a full dental arch is recommended.





CBCT

Preparation for the CBCT

To perform CBCT scans, follow the device manufacturer's instructions.

To optimize the results, prepare the patient according to the recommendations:

- Before the examination, the patient should take off glasses, hair clips and head and neck jewelry.
- All metal parts that are not fixed in the mouth must be removed for the duration of the examination (dentures with metal parts, earrings on the tongue).
- Before placement of a radiological template to the patient's mouth, check that all x-ray markers are permanently attached to it.
- **IMPORTANT:** Insert the lignin rollers between the teeth to ensure stable distance and position of the dental arches or use a special positioner / pin during the test. In case of examination with radiological templates in the situation of edentulous or extensive tooth deficiencies, silicone keys should be made and the patient's head should be positioned with the chin supported.
- Additionally, lignin rollers can be inserted into the vestibule to move the lips and cheeks away from the dental arches.
- Make sure that the tongue does not touch the palate during the examination.
- Select the correct Field of View size (FOV).

Instructions for the patient

- Please do not move during the examination.
- Please do not swallow saliva during the examination.

DICOM export

- Data from the examination are stored in DICOM files (Digital Imaging and Communications in Medicine) - a standard developed by ACR (American College of Radiology) and NEMA (National Electrical Manufacturers Association) for the purpose of unifying the exchange and interpretation of medical data representing or related to diagnostic images in medicine.
- **IMPORTANT:** Please burn a folder with uncompressed DICOM files to the disc or other media. There is no need to record the viewer for the examination.
- Scan data export as uncompressed DICOM files of individual frames.

Data transfer

- The CBCT examination can be sent using courier services. Burn a CD/DVD or pendrive and protect against damage during transport.
- The preferred method is to send a folder with DICOM files using the platform: **www.wetransfer.com**
- The folder with DICOM files should be compressed in one of the dedicated programs before sending (eg WinRAR, WinZIP, Hamster ZIP Archiver). Sending a compressed folder protects against errors that may occur during the transfer of large data sets electronically.

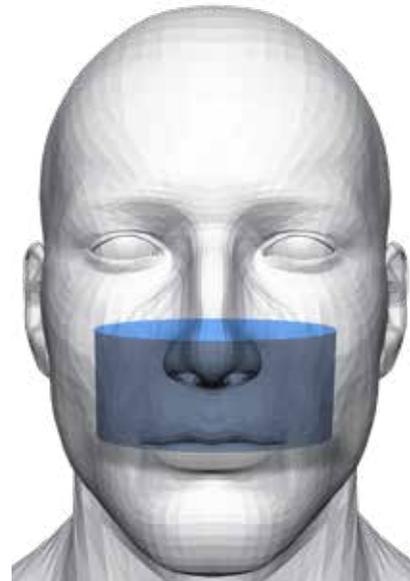
Compression softwares

- WinZIP: www.winzip.com
- WinRAR: www.win-rar.com
- Hamster ZIP Archiver: www.ziparchiver.hamstersoft.com

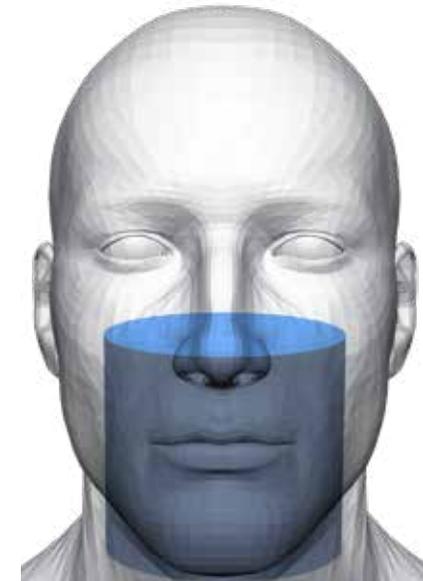
The field of view for implantological treatments recommended by the American Academy of Oral and Maxillofacial Radiology is 10: ratio. The limited field of view (FOV) during CBCT examination should be considered as the preferred type of imaging for the surgical placement of implants.



FOV 10x5



FOV 10x5



FOV 10x10

* Tyndall D, Price J, Tetradis S, Ganz S, Hildebolt C, Scarf W. Position statement of the American Academy of Oral and Maxillofacial Radiology on selection criteria for the use of radiology in dental implantology with emphasis on cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;June;113(6):817-26.

CBCT

Examination with a radiological template

In the case of edentulous or extensive missing teeth, it is recommended to perform CBCT examination with a radiological template. The radiological template can be a prosthesis or a copy of it and should take into account the optimal position of the teeth. If old prosthetic restorations do not meet these requirements, new ones should be made that will be the pattern for the templates.

Types of recommended x-ray templates for edentulous or extensive missing teeth cases:

- The existing denture of the patient with embedded markers - can not have metal elements or reinforcements.
- Template made of transparent acrylic with embedded markers made by duplicating an existing denture.
- 3D printed radiological template made on the basis of an existing denture scan or digital prosthesis template (STL file) with embedded markers.

Markers - size and location

- The aim of the markers is to create reference points allowing DICOM radiological images to be integrated in the implant planning software with other data.
- Markers can be integrated with others DICOM files (Dual Scan Technique) or with digital STL images acquired from scanning dentures/radiological templates.
- The optimal size of the markers is 2-3mm and should be round.
- The most commonly used materials for markers: gutta-percha, composite material, glass balls (preferred).
- The number and position of the markers depends on the design and size of the radiological template. A minimum of 6-8 markers is required. It is optimal to put more of them.
- Markers should be positioned in such a way that they are also visible after scanning the radiological template in the optical scanner.
- Place them on different planes, however below the level of the teeth. Half of the markers should be on the palatal side and the other should be from the vestibule.
- Markers should be convex and protrude from the prosthesis.

Recommendations for dentist and X-ray staff before CBCT examination:

- Radiological templates must be in a stable and open bite position during examination. Prepare "occlusion keys" made of acrylic or other transparent material for X-rays. The keys have to stabilize the gums of the jaws and jaws in the stable relation and move the lower arch from the upper by about 2-3mm.
- The radiological template must adhere very precisely to the soft tissue so that there is no "air cushion".
- Position the patient's head in the CBCT using the chin support.



Positioning of the Patient's head in a Kodak Carestream CS 9300S with a chin support.

Dual Scan



Dual Scan

DUAL SCAN technique with the patient's prosthesis

The CBCT scan technique allows you to get all the required data to create a surgical template for a computer navigation procedure often without the need for a radiological template and model casting.

This technique should not be performed if the patient's prosthesis has metal reinforcement or if the position of the teeth and the shape of the arch are changed, because we do not want to plan the implants in the old occlusion pattern.

STEP 1: Make sure that the denture is very well fitted, which will translate into a matching surgical template.

STEP 2: If the prosthesis does not fit perfectly, it should be relined with a light body silicone material (PVS) without using glue.

STEP 3: After drying the denture, place the markers on the plate. They should be placed on various planes on the buccal and palatal or lingual sides. At least 6 markers must be placed.

STEP 4: Make a bite of silicone material at least 3mm thick so that the teeth of the jaws do not touch each other during the examination. The obtained bite will serve as a bite key. Optional is to use the thick cotton rolls to hold an open bite during examination.

STEP 5: SCANS - 2 CBCT scans will be performed before removing the relining material from the base of the prosthesis and removing the scan marks.

Scan 1: CBCT of a patient with a prosthesis and occlusion bite (key) in the mouth in the occlusion, so that the prosthesis is properly placed on the ground. Open bite.

Scan 2: CBCT of the denture without patient - with markers and relining material still in place. If the Patient has 2 dentures than upper and lower denture should be scanned in the separate procedures (Scan 2 for upper and Scan 3 for the lower denture)

STEP 6: Images from the first and second scan should be saved in DICOM format and placed in separate folders.

Typical errors

1. During the scan, the dentures were moving and poorly embedded in the oral cavity, which may result in incorrect adjustment of the surgical template.
2. The radiological markers were removed before both scans were taken. It is not possible to merge images and integrate the data
3. The denture during the scan in the mouth was without markers. Markers were added but only in the case of a scan of the prosthesis outside the oral cavity. It is not possible to submit images.



Dual Scan

Examination with a radiological template.

The Dual Scan procedure can be performed both in the classical computed tomography (CT) and cone beam computed tomography (CBCT). This examination can be carried out when the patient has a prosthesis or a prepared radiological template with optimal x-ray translucency. First, make new dentures for the patient to obtain optimal information about the spatial position of the teeth during implant planning if it is planned to change the position of the teeth.



In the edentulous cases or extensive deficiencies requiring a change in the position of the teeth, an optimal position in the next prosthetic restoration should be determined, starting with the wax reams.



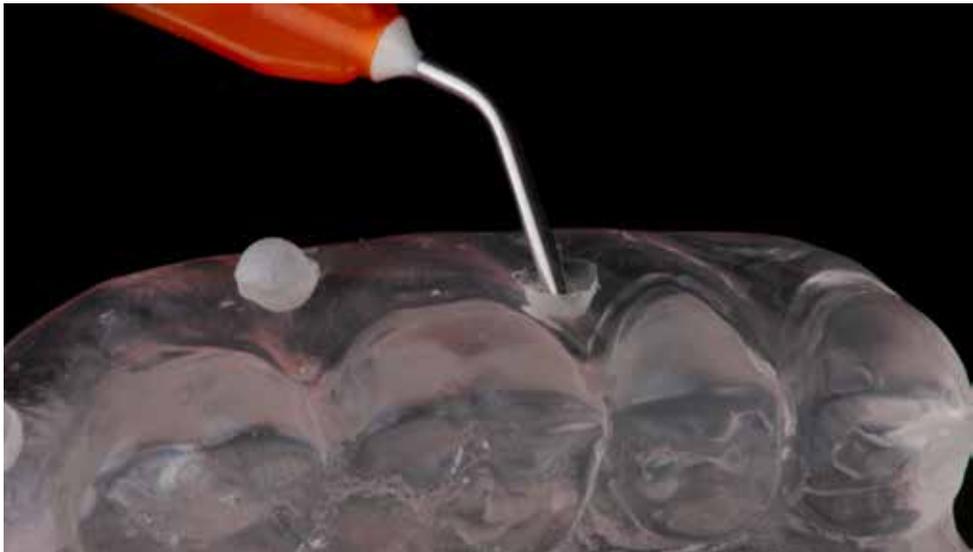
Based on the measurements, you can make a transparent acrylic denture that will serve as a radiological template. Optimal translucency for X-rays characterizes transparent acrylic.



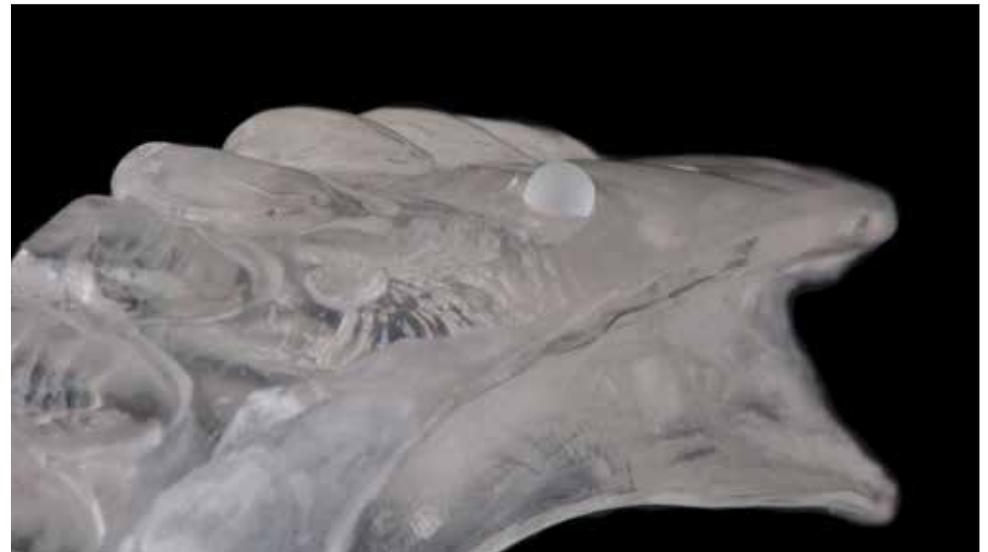
The image of the partial upper denture made of transparent acrylic. The X-ray prosthesis cannot have metal braces and reinforcements. In such a prosthesis should be embedded radiographic markers.



It is optimal to use sandblasted balls as x-ray markers (they will also be visible in the optical scanning process). The balls should be embedded in the prosthesis. The picture shows a glass ball with a diameter of 2.5mm.



After making the recesses with a drill, the balls should protrude above the surface of the acrylic. A flow type composite (with low filler content) can be used for fixing.



The X-ray template should have markers on the vestibular and lingual/palatal side. The position of the markers is below the zenith of the teeth as close as possible to the alveolar ridge.



Upper partial denture with visible embedded markers on the denture base. The placement of markers should be irregular.



View of the markers in the upper prosthesis from the vestibular and palatal side. Embedded balls should protrude from the contour of the prosthesis.



View of the prepared X-ray template for edentulous mandible. Embedded markers are visible on the vestibular and lingual side. Irregular positioning helps in a precise merging of the data.



An X-ray image of the radiological template obtained with CBCT. Different radio translucency of X-ray markers and denture base helps to create separate layers during the segmentation process in the coDiagnostiX® software.



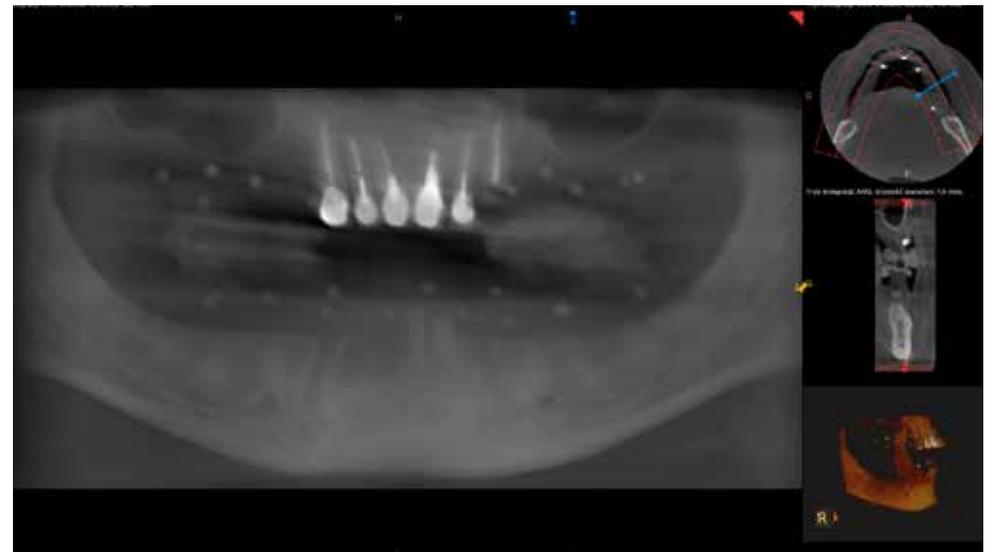
Before starting the examination, relining of the radiological template in the patient's mouth with the low body silicone impression material is necessary. It helps to transfer precise information about the mucosa in the dual scan technique.



Relining can be done with silicone or polyether materials as in this case. Pay attention to thoroughly position the templates in the mouth in the correct bite. Denture has to adhere to the mucosa of the ridge.



During the examination, the dental arches must be distant from each other (open bite). Use the bite registration material or cotton rolls to stabilize the templates in the open bite position and press against the soft tissue.



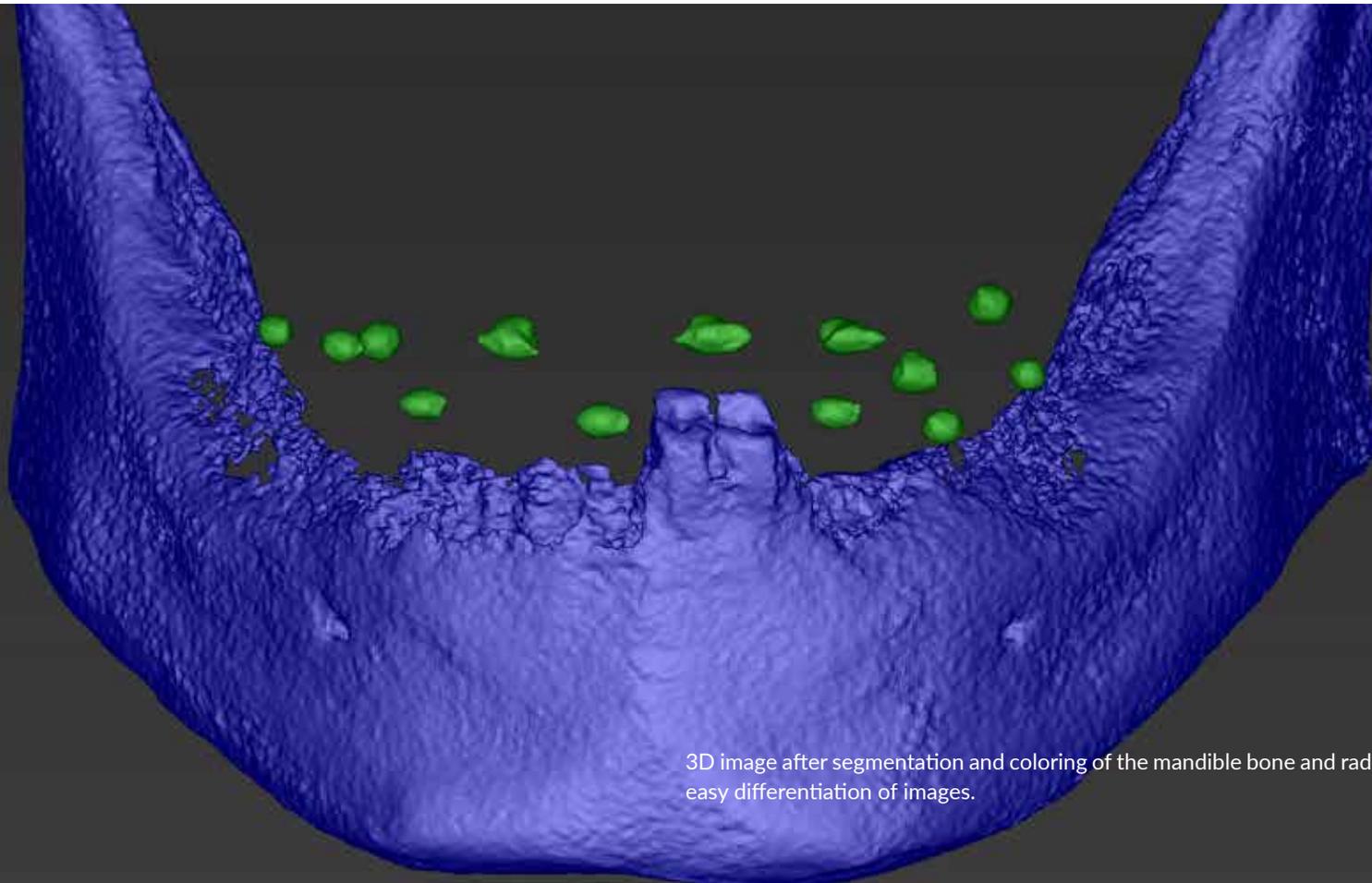
As a result of the CBCT examination with radiological templates, we obtain an image of the jaws together with x-ray markers, which will serve to position the image of the prosthesis against the bone in the planning software.



3D image obtained in Kodak Carestream CS 9300S cone beam computed tomography (CBCT). X-ray markers embedded in the radiological template are clearly visible in the picture.

First Scan - CBCT of a patient wearing a prosthesis with markers

- The first scan is CBCT examination of a patient wearing an x-ray template (without metal reinforcements) with embedded x-ray markers in open bite. The bite record or cotton rolls are used to stabilize the prosthesis during the examination and to move the teeth apart from each other by a minimum of 3mm. Obtaining an image of occlusal surfaces free from contact with opposing teeth facilitates the integration of DICOM and STL files in the planning process.
- The positioning of the patient is comparable to a standard CBCT examination. Make sure that the cross-sectional plane is parallel to the occlusal plane!
- The upper and/or lower arches with the prosthesis should be completely covered in the imaging field (MFOV).
- To create a precise template for guided surgery, a full scan is required.



3D image after segmentation and coloring of the mandible bone and radiological markers for easy differentiation of images.



Second Scan - CBCT scan of prostheses with X-ray markers.

- When performing the second scan, it is essential to position the prosthesis in the same way it was placed in the patient's mouth during the first scan. It means that the left/right and top/bottom orientation should be correct = the same as in the patient's mouth scan.
- The material used to support the prosthesis must be more radiolucent than the prosthesis itself. Polyethylene and polyurethane foam materials are an excellent example of materials that can be used when scanning CBCT. Some CBCT manufacturers offer ready-made supports for this procedure.





Example of the settings for the second scan of the acrylic x-ray template in the Kodak Carestream CS 9300S.



Advice: set the lowest dose for the CBCT scan of the x-ray template in the dual scan technique.



3D image of a radiological template with radiographic markers obtained in the Kodak Carestream CS 9300S.

Digital impression





Digital impression and digital model

For digital planning, it is necessary to create a digital model saved in STL format. We have three main techniques for creating such a model:

- Digital impression with intraoral scanner (IOS)
- Direct scanning of alginate or silicone impression with intraoral or laboratory scanner
- Scanning of the plaster model with intraoral (IOS) or laboratory scanner

The effect of the scanning process is to obtain a 3D image, which is saved in STL format.

STL (Stereolithography) – file commonly used as a standard in Rapid Prototyping methods. Most CAD software provides the option to write in the STL output format. The STL format is a triangulation (triangular) representation of the surface geometry in three-dimensional space. Each surface is divided into a series of small triangles, and then each vertex of the triangle is described by 3 points representing their position relative to the coordinate axes.



Scanning impressions makes it possible to obtain a 3D model bypassing pouring the plaster model.

Intraoral scanner

Review of current literature.

Mangano F, Gandolfi A, Luongo G, Logozzo S. Intraoral scanners in dentistry: a review of the current literature. BMC Oral Health. 2017;17:149.

Intra Oral Scanners (IOS) are devices for recording direct optical impressions in dentistry.

Conclusions:

Optical impressions reduce patient discomfort; IOS are time-efficient and simplify clinical procedures for the dentist, eliminating plaster models and allowing better communication with the dental technician and with patients; however, with IOS, it can be difficult to detect deep margin lines in prepared teeth and/or in case of bleeding, there is a learning curve, and there are purchasing and managing costs. The current IOS are sufficiently accurate for capturing impressions for fabricating a whole series of prosthetic restorations (inlays/onlays, copings and frameworks, single crowns and fixed partial dentures) on both natural teeth and implants; in addition, they can be used for smile design, and to fabricate posts and cores, removable partial prostheses and obturators. The literature to date does not support the use of IOS in long-span restorations with natural teeth or implants. Finally, IOS can be integrated in implant dentistry for guided surgery and in orthodontics for fabricating aligners and custom-made devices.WW







Scanning of the analog model

Taking a classic impression using alginate or silicone material (PVS) is aimed at obtaining a mapping of the clinical situation on the plaster model. Such a model can be scanned to create an STL file.

In some situations, taking a classic impression, casting a plaster model and surface scanning on a laboratory scanner is the preferred technique for intraoral scanning.

Indications:

- edentulous cases
- free end situations (especially in the lower jaw)
- planned support for a surgical template on a full dental arch





Laboratory scanner, so-called desktop is mainly used in dental laboratories and clinics with laboratory facilities. This universal type of scanner features outstanding scanning versatility, speed and accuracy as well as a wide range of applications in prosthetic design.

Virtual models can be generated by scanning impressions and plaster models. In the future, impression scanning is expected to become the standard for capturing 3D images.

Implant planning



Implant planning

Proper planning of the implant position is the basis for designing of the surgical template.

There are many planning softwares available that have many things in common. There are also significant differences between them that give the user additional functions and possibilities. In our center, we mainly use the coDiagnostiX™ software (Dental Wings). This program gives us many possibilities, including:

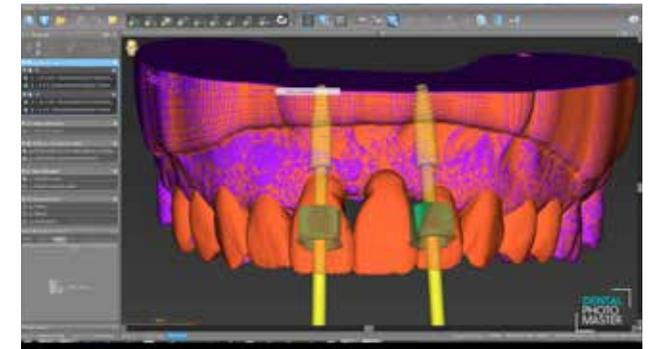
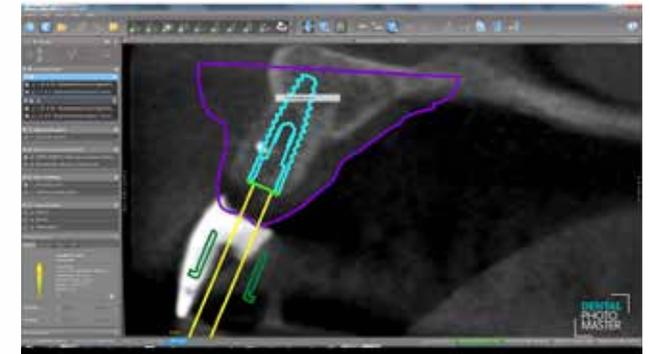
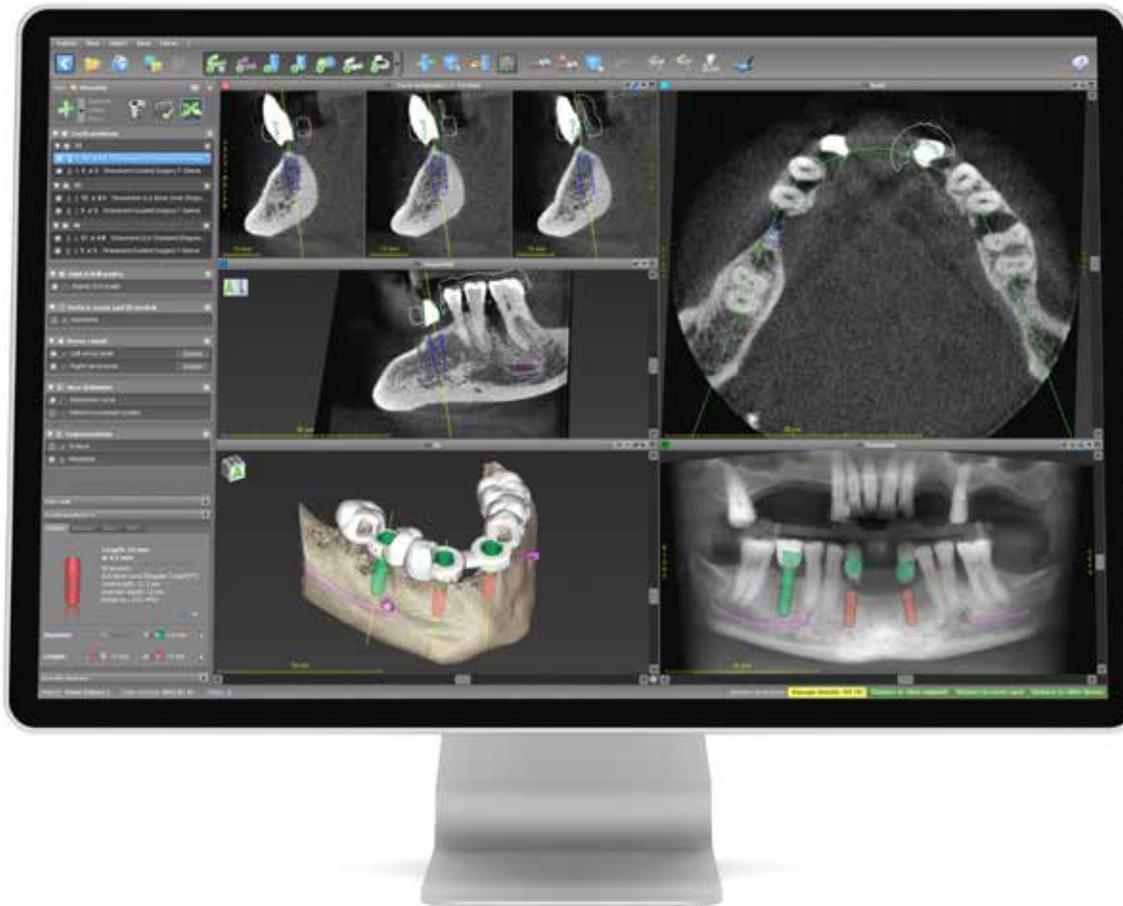
- Planning the type, model and size of the implant (length and diameter) from the existing implant library or we can create an individual implant model knowing its dimensions
- Determining the location of implants with each other (parallelism and tolerance of discrepancies).
- Determining the position of the implant index - the orientation of the connection for the abutment, which allows you to plan the position of the implant relative to the angled abutment.
- Selection of prosthetic abutments - height and angulation along with measurements of discrepancies between them, which facilitates the planning of full-arch restorations.
- Adding a virtual tooth (digital wax-up) from either the program library or by adding an STL file.
- Synchronization through so-called "Synergy" with a laboratory program for the design of prosthetic work, allows for preparing the temporary restoration, an individual abutment or an individual healing screw before surgery.



coDiagnostiX™

- coDiagnostiX™ also allows you to design templates based on teeth, soft tissue, bone, mixed and special, such as bone reduction guides, templates for endodontic treatment, templates for Sinus Lift.
- Selection of the sleeves for osteotomy and full implant guidance.
- Possibility to select drilling sleeves from independent producers.
- Possibility to generate reports containing a surgical protocol, materials for the procedure, individual positions of implants.
- Different language versions are available

The complexity of the case, the type of planned template and the implant system will influence the selection of the appropriate planning program. If the Clinician has his license of the coDiagnostiX™ program, it is possible to set a remote connection with the Planning and Print Center to speed up the workflow. The leading programs are regularly updated and have built-in implant libraries. The number of implant systems is continuously increasing, and libraries update provides greater versatility during the treatment plan. The dentist has a choice of all available models and sizes of implants (given manufacturer), which gives full possibilities to select the right tools in the planned case.



Planning for implant treatment in the coDiagnostiX™ program involves few steps:

- import of DICOM files
- STL image import
- submission of DICOM and STL images
- import of the Swax-up or digital prosthetic plan
- planning the position of the implant relative to the optimal prosthetic position
- planning a template for computer navigation and its export

Implant planning guidelines

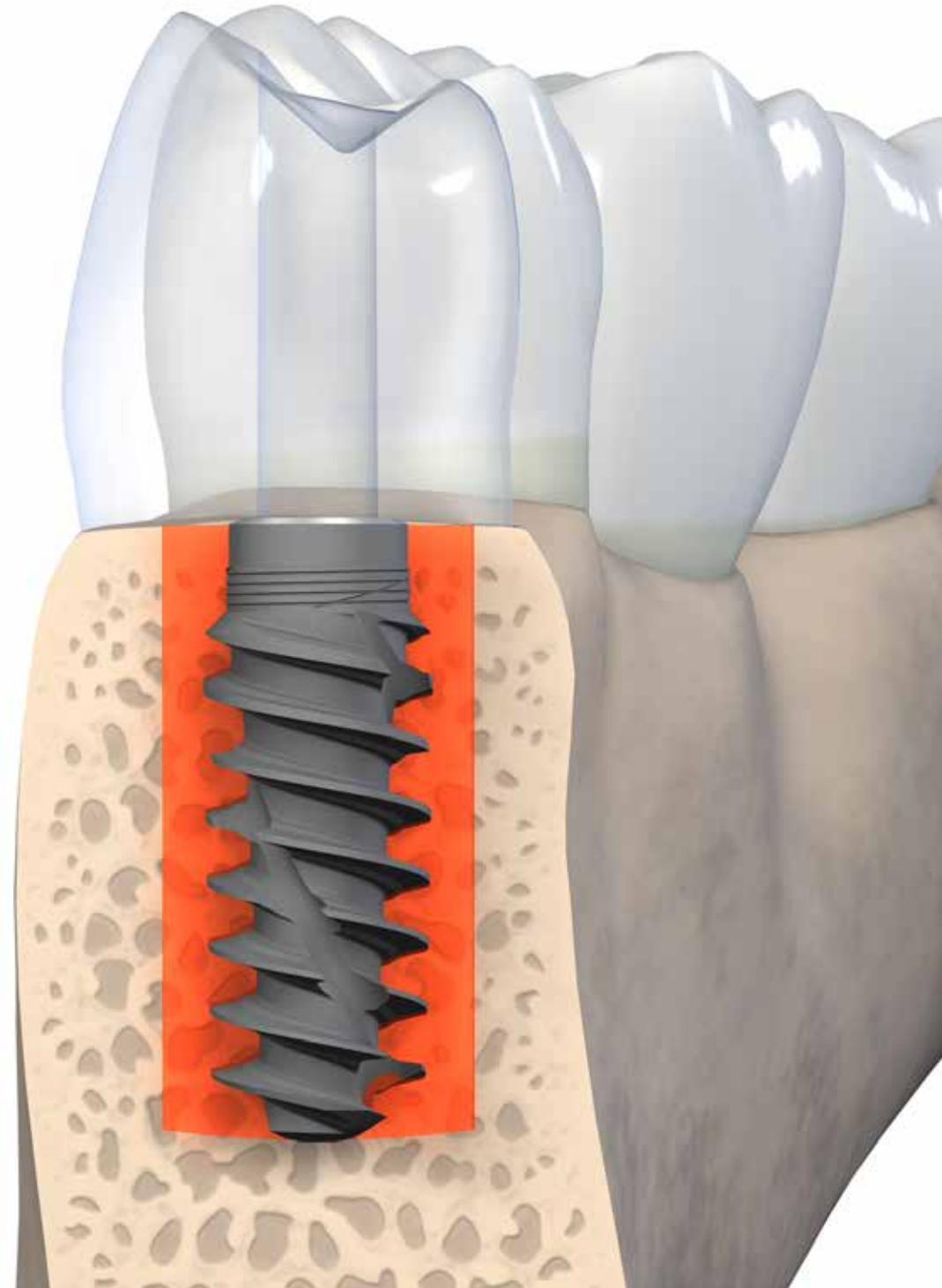
Basic rules

Prosthetic-driven planning is recommended, and close communication between the patient, dentist, surgeon and dental technician is imperative for achieving the desired esthetic result.

To determine the topographical situation, axial orientation and the appropriate implants, making a wax-up / set up using the previously prepared study cast is recommended. Subsequently, the type of superstructure can be defined. The wax-up / set-up can later be used as the basis for a custom-made x-ray or drill template and for a temporary restoration.

Note: Abutments should always be loaded axially. Ideally, the long axis of the implant is aligned with the cusps of the opposing tooth. Extreme cusp formation should be avoided as this can lead to unphysiological loading.

The mesiodistal bone availability is an important factor when choosing the implant type and diameter as well as the inter-implant distances if multiple implants are placed. The point of reference on the implant for measuring mesiodistal distances is always the largest diameter of the implant.



Rule 1:

Distance to adjacent tooth at bone level



A minimum distance of 1.5mm from the implant adjacent tooth (mesial and distal) is recommended.

Rule 2:

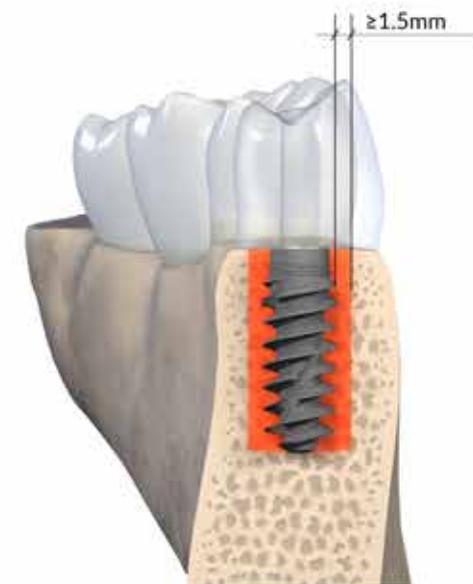
Distance to adjacent implants at bone level



A minimum distance of 3mm between two adjacent implant shoulders (mesiodistal) is recommended.

Rule 3:

The facial and palatal bone thickness at least 1.5mm



The facial and palatal bone layer must be at least 1.5mm thick in order to ensure stable hard and soft tissue conditions. Within this limitation, a restoration-driven orofacial implant position and axis should be chosen such that screw-retained restorations are possible.

Caution: An augmentation procedure is indicated if the orofacial bone wall is less than 1.5mm or a layer of bone is missing on one or more sides.

DICOM import

Implant planning programs require that files delivered from a CT or CBCT examination should be stored in an uncompressed DICOM format.

Segmentation

After importing DICOM images into dedicated software, the process of segmentation of the image should be carried out.

*In the computer images, image segmentation is the process of dividing a digital image into multiple segments (sets of pixels, also known as superpixels). The purpose of segmentation is to simplify and/or change the representation of the image into something that is more meaningful and easier to analyze. Image segmentation is usually used to locate objects and boundaries (lines, curves, etc.) in images. More specifically, image segmentation is the process of assigning a label to each pixel in an image so that pixels with the same label have certain characteristics.

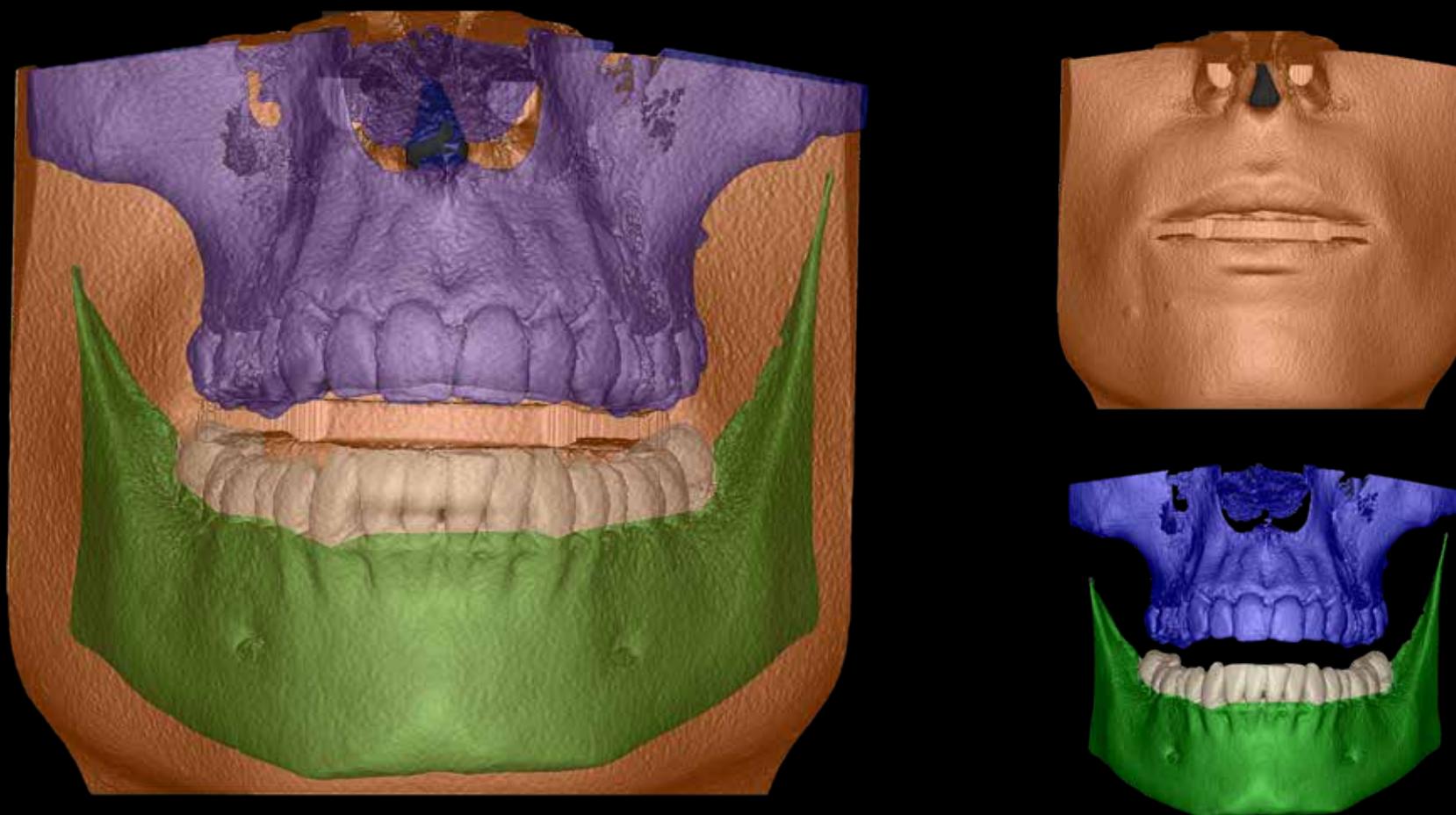
The result of image segmentation is a set of segments that together comprise the entire image or set of outlines extracted from the image. Each pixel in the region is similar in relation to some characteristic or calculated properties, such as color, intensity or texture. The neighboring regions differ significantly in terms of the same features.

When applied to a stack of images, typical of medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions using interpolation algorithms.

The image obtained as a result of segmentation is simplified in relation to the image subjected to segmentation - this image does not contain many detailed information appearing in the original image.

Advanced implant planning programs have built-in algorithms and various segmentation methods that aim to precisely identify structures that are of interest to the clinician. From the set of data being the basis for the creation of the default 3D reconstruction, it is possible to distinguish many structures that, after additional coloring, allow for easier differentiation of areas, but also enable and disable their visibility in the planning process.

* https://en.wikipedia.org/wiki/Image_segmentation



Segmentation images obtained in the coDiagnostiX™

- Brown color - facial skin
- Blue color - upper jaw with the teeth
- Green color - lower jaw
- White color - lower dentition

Merging data

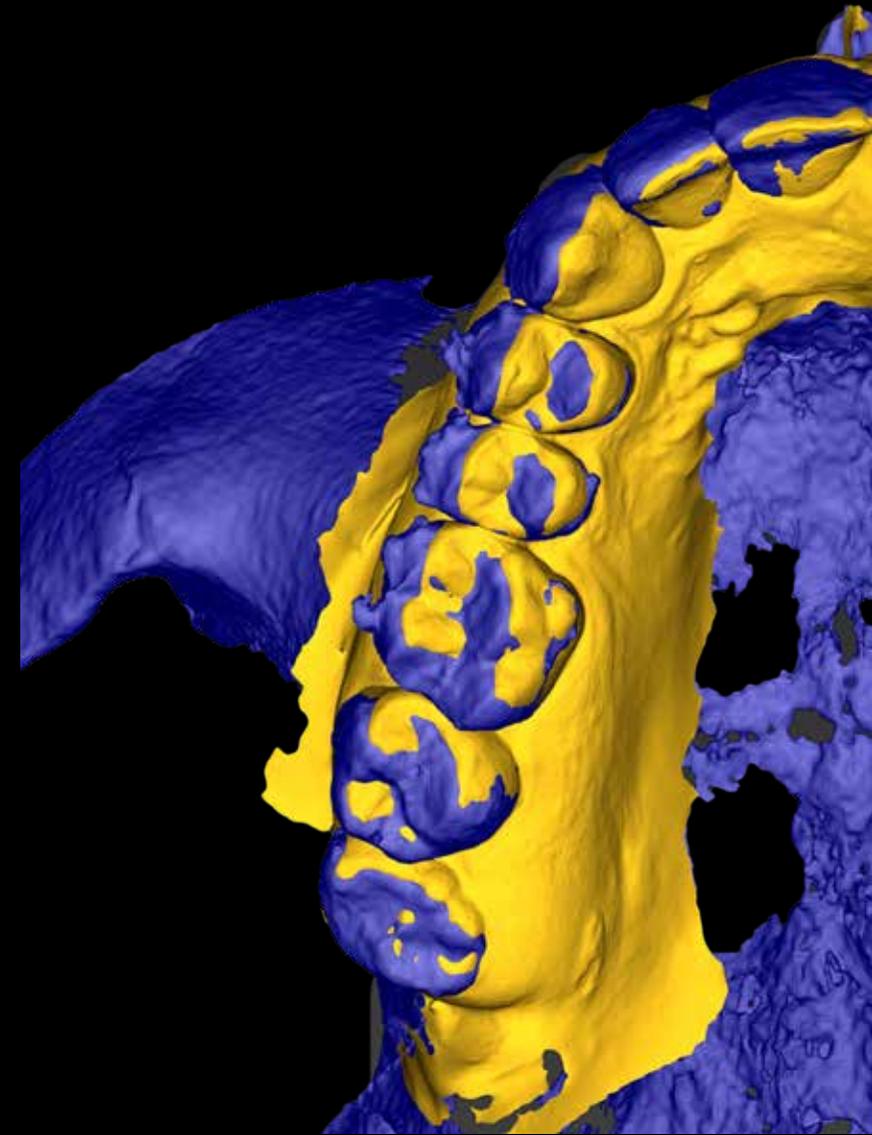
DICOM and STL files

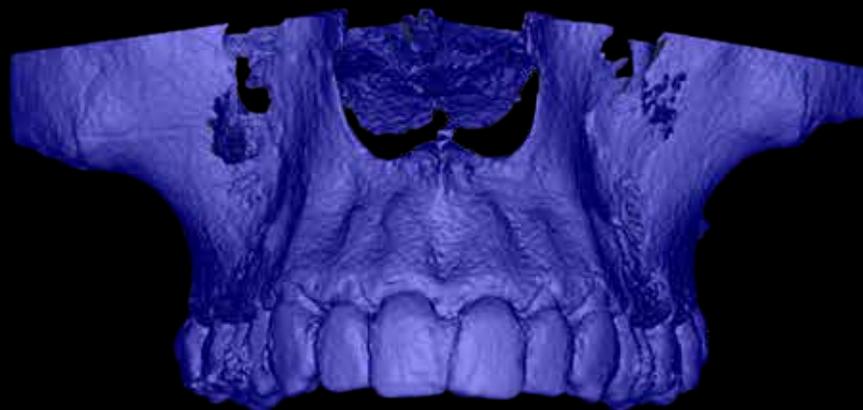
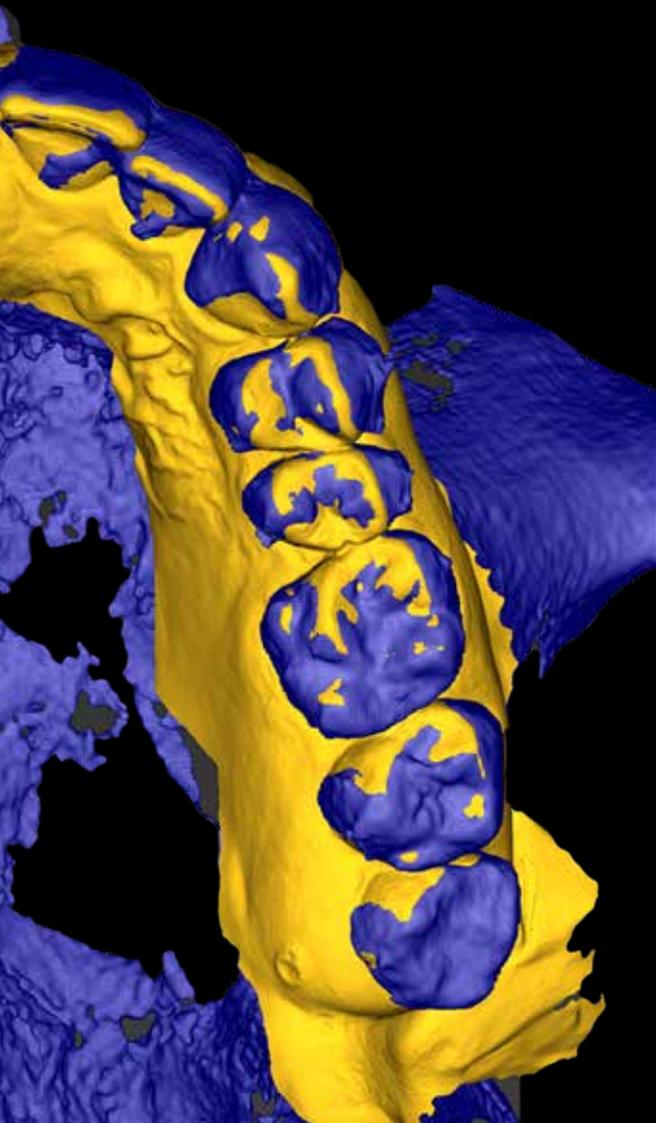
Data integration consists in combining data from different sources and providing users with a uniform view.

STL files contain necessary information about the position of soft tissues, teeth and prosthetic restorations.

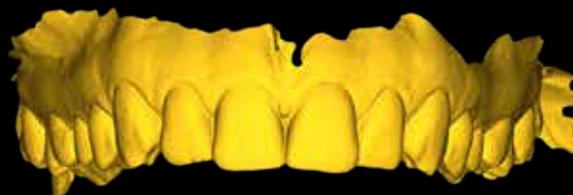
In the implant planning software, the process of combining CT/CBCT data, that is DICOM files and images from an intra oral scanner or a laboratory scanner (STL files), is performed by indicating common points. The seemingly simple process incorporates advanced technologies that, by comparing hundreds of convergent points, create consistent images. **The accuracy of matching individual images is the foundation of the precision of the surgical procedure.**

Computer navigation templates are planned based on two images: DICOM and STL. However, the superior image to create the template is the image of the soft tissues and the teeth contained in the STL file. If data integration (DICOM + STL) is inconsistent and inaccurate, this will lead to incorrect determination of the drilling axis for the implants.

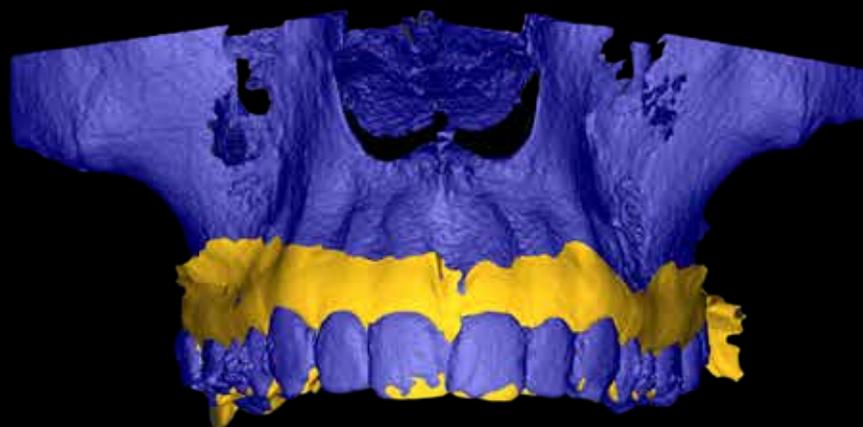




Jaw segmentation based on the DICOM files.



STL file - image of the teeth and soft tissue obtained from the intraoral scanner.



Integrated DICOM and STL files.

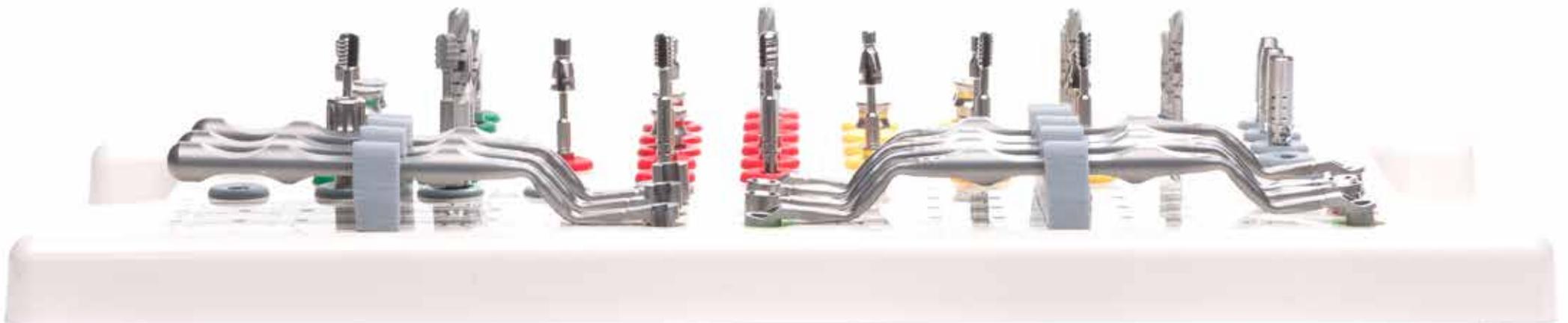
Implant systems

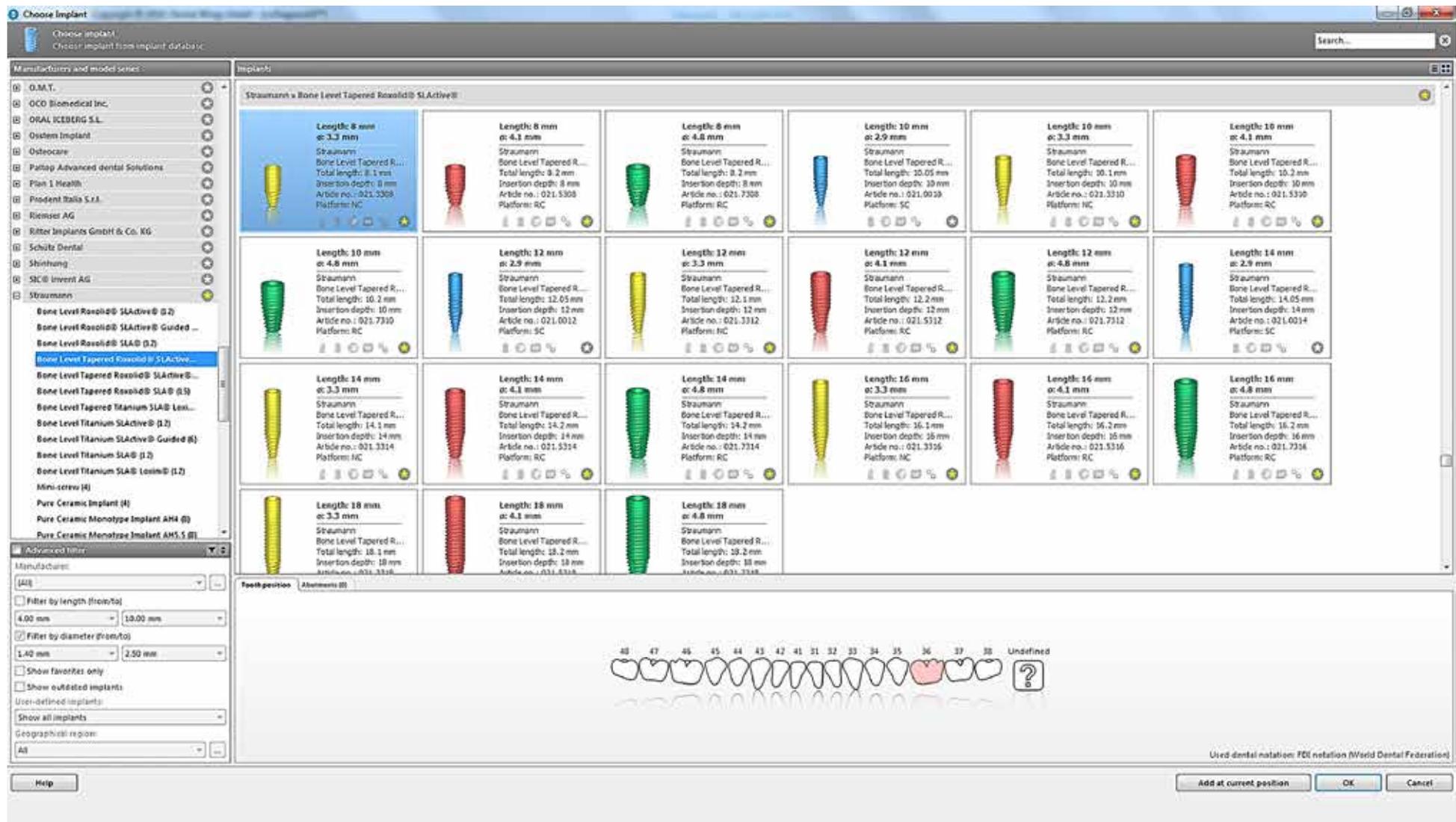
Libraries

The implant planning software CoDiagnostiX™ is an open program and has an integrated database with implants from various manufacturers including the Straumann® implant portfolio. The database is constantly updated. The user can check at any time via online update whether new data is available.

Depending on the tools offered by the manufacturer of the implant system, the program allows you to design a template compatible with the tools dedicated to computer navigation. This means that the program automatically suggests which sleeves should be used as drill guides or allows you to generate a surgical report that guides you through the process step by step during the procedure.

Some manufacturers' libraries also contain information about prosthetic abutments. These are very valuable data because at the stage of determining the position of the implant one can also plan the type of the abutment, its angularity and the height of the soft tissue. The position of the abutment will have a big influence on the orientation of the index / connection in the implant. The advantage of the coDiagnostiX™ program is the ability to add markings on a computer navigation template that are a reference for the implant index position.





The implant libraries in the coDiagnostiX™ software allow you to plan most popular implant systems, from premium brands such as Straumann to less well-known products.

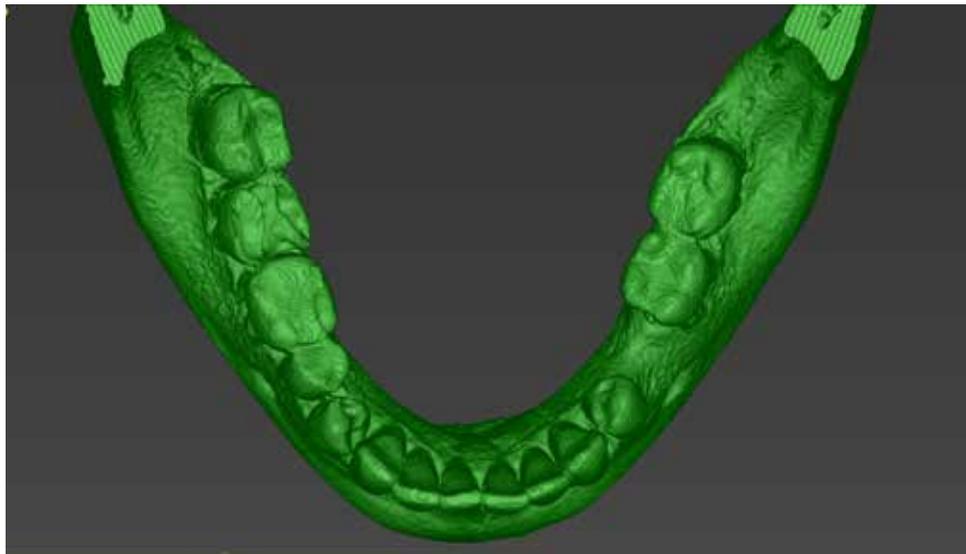
In the implant position planning mode, we can choose the model, diameter, length and pre-position selected on the tooth diagram. In addition, we can plan and set positions for pins that stabilize the template in the bone.

Integration and planning

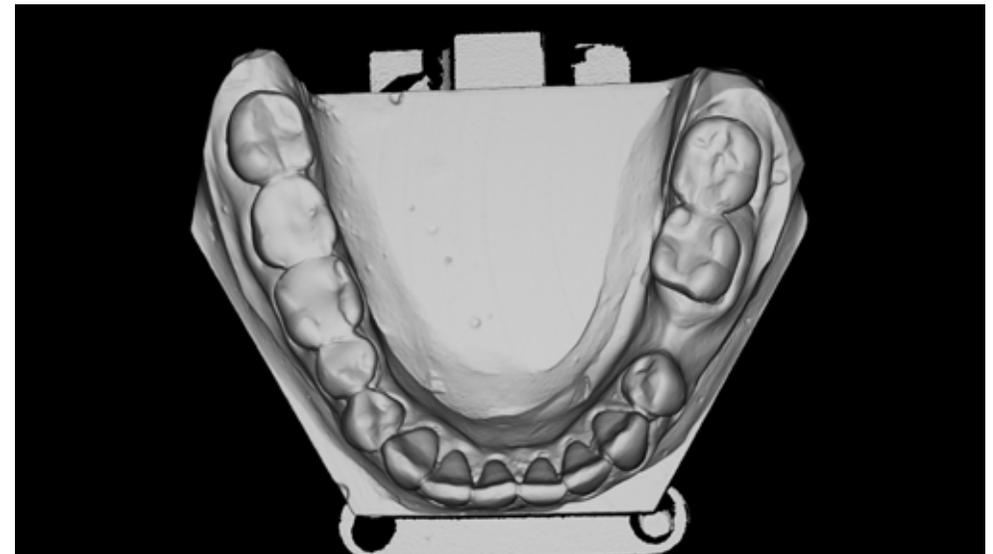
Single tooth restoration

The integration of DICOM and STL files in the absence of a single tooth is an easy process due to the presence of dentition, which is the reference for integration. The only obstacle that can occur during image merging process is the presence of artefacts resulting from the diffusion of X-rays by metal-based restorations and sintered metal oxides.

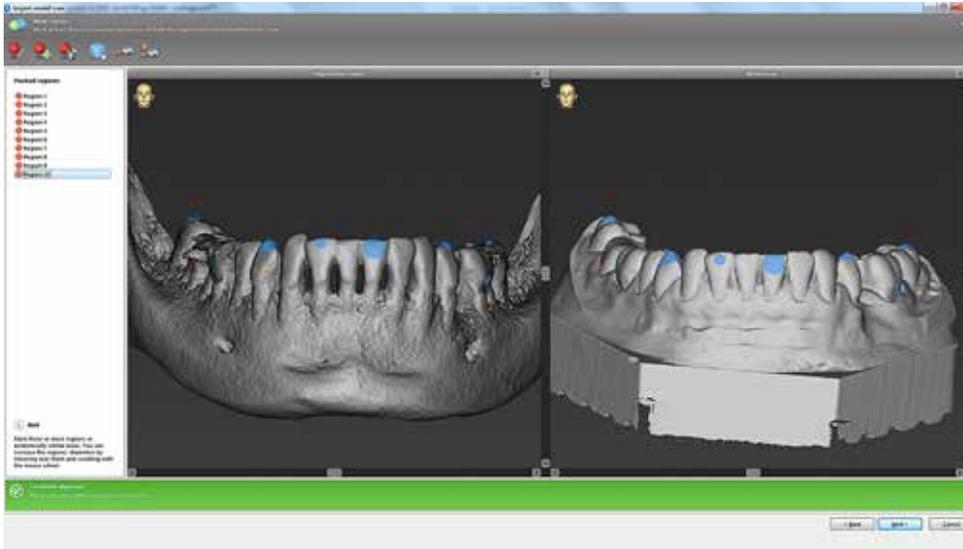
The stage of data integration and implant position planning in the coDiagnostiX™ program is determined by step-by-step procedures. This makes it easier to carry out this process efficiently even for novice users without experience in handling such programs.



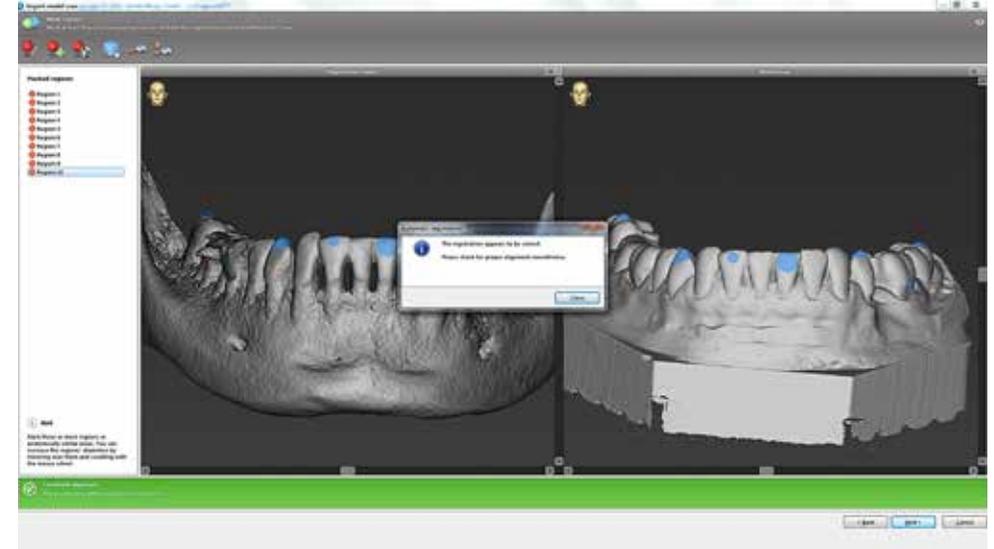
3D reconstruction obtained from CBCT is the first action after importing DICOM files. The segmentation process allows distinguishing the mandible with the teeth as a separate colored layer.



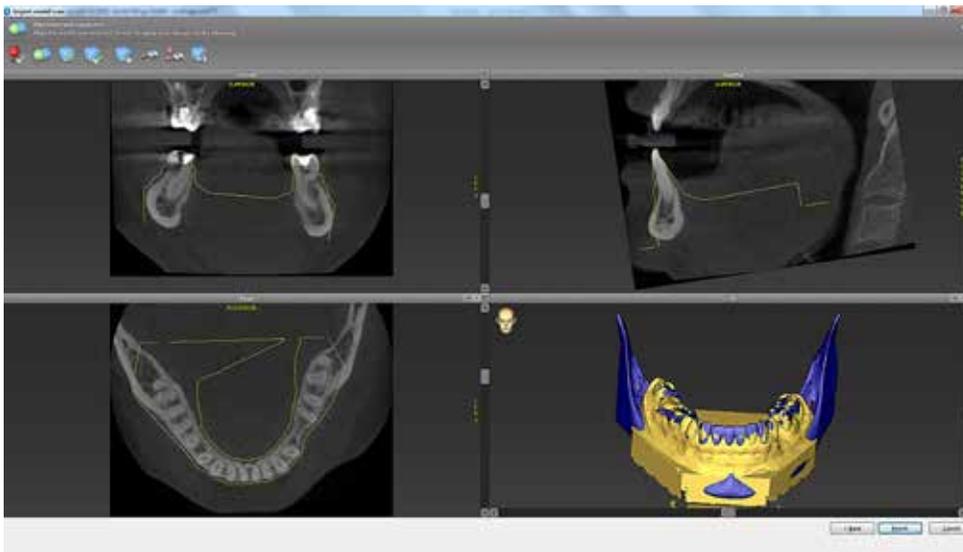
The STL image, obtained in a dental laboratory from a plaster model scan, should be saved in the patient's folder for easy access and path selection.



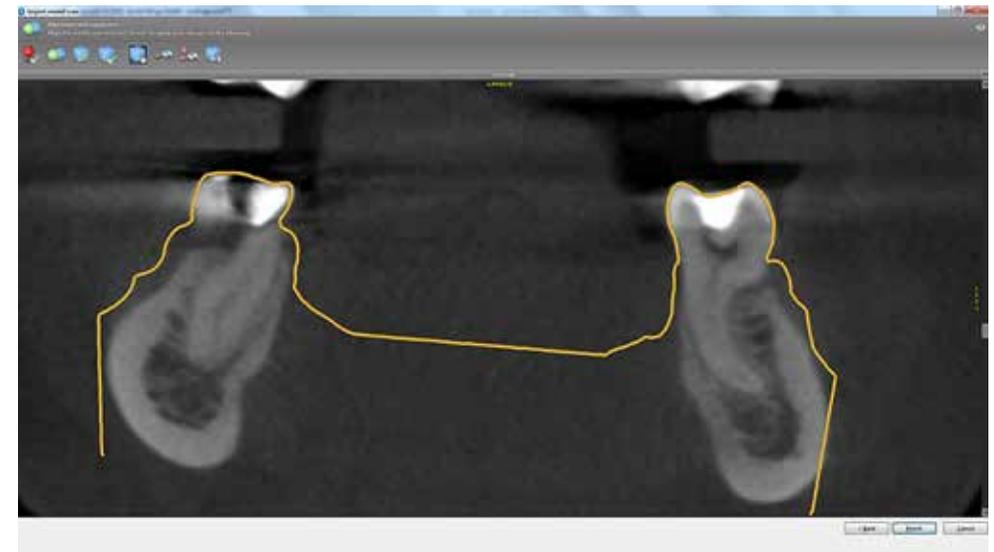
To merge data, the STL file import module is started. The left window displays 3D segmentation, and the right image shows the STL model. Between the objects, the points common for image integration are marked.



The correctness and consistency of the marked points are communicated by the appearance of the green bar below and in the dialog box. The program still asks to check for proper alignment in the next step.



The control window allows you to check the alignment of the images. There are four windows in which we can trace and correct images in different cross-sections and a 3D image.



When assessing the correctness of image alignment, it should be noted if the outline of the model is consistent with the outline of the shape of the teeth. A view in the coronal plane.

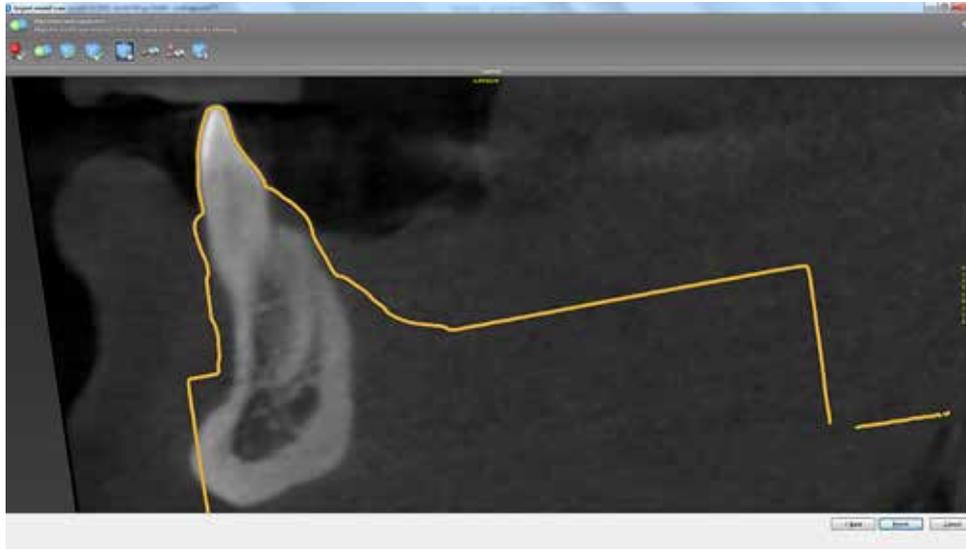
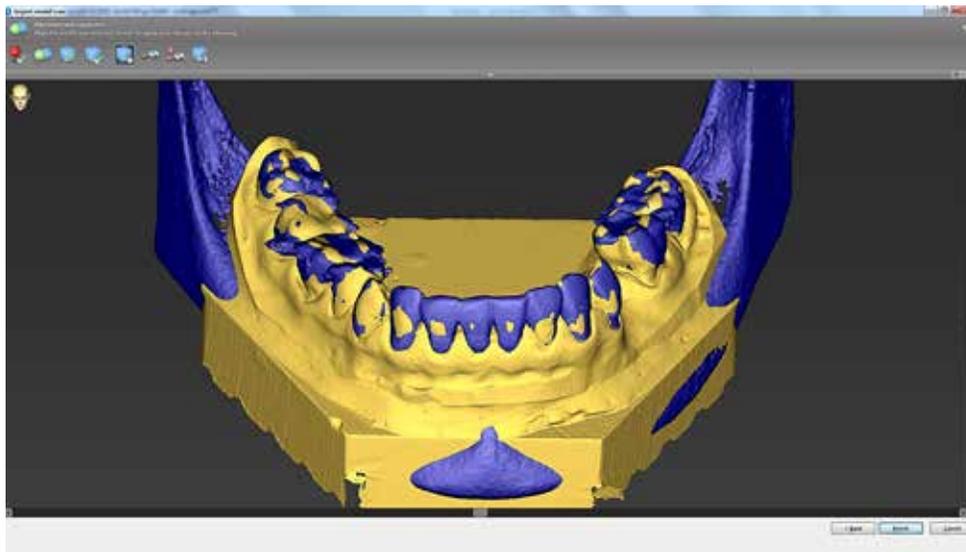


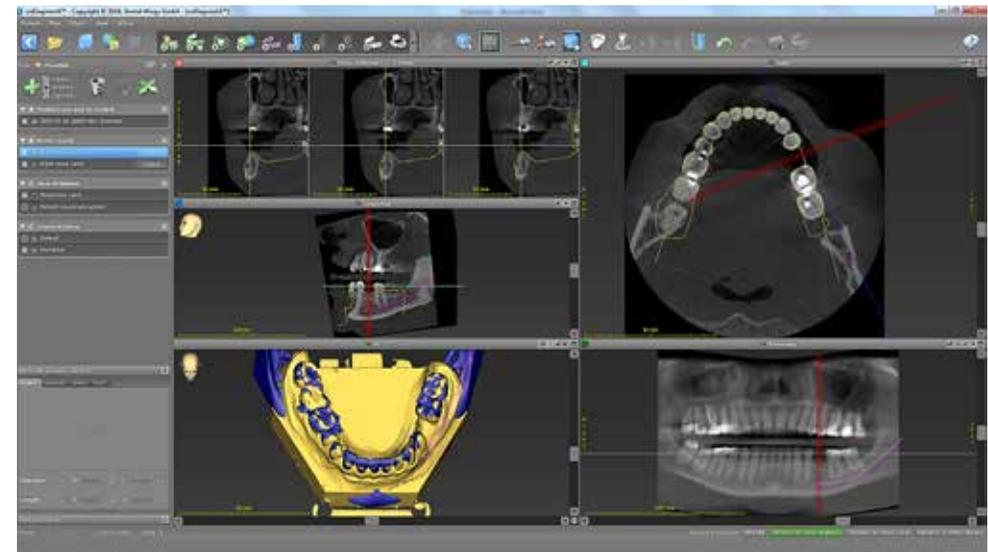
Image control in the sagittal plane.



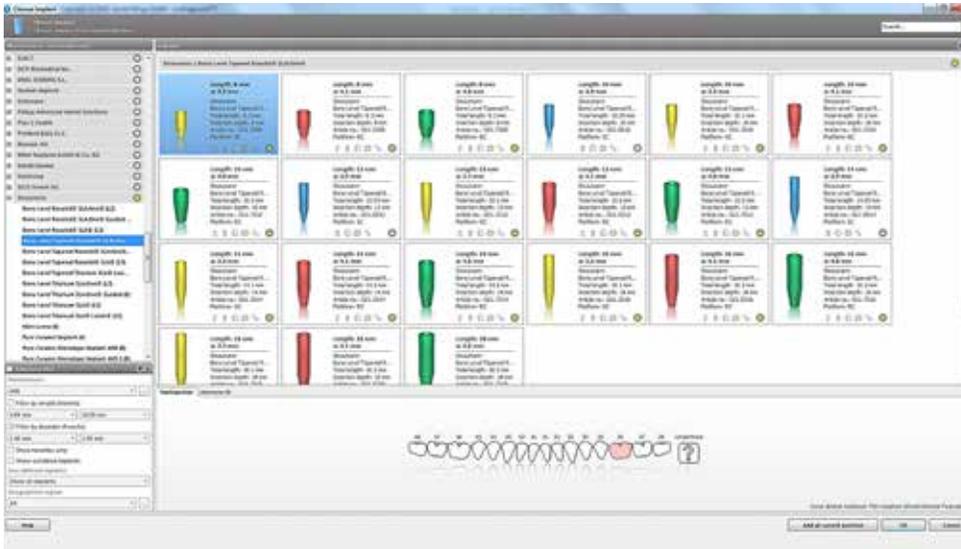
Checking the correctness of image alignment in the axial plane.



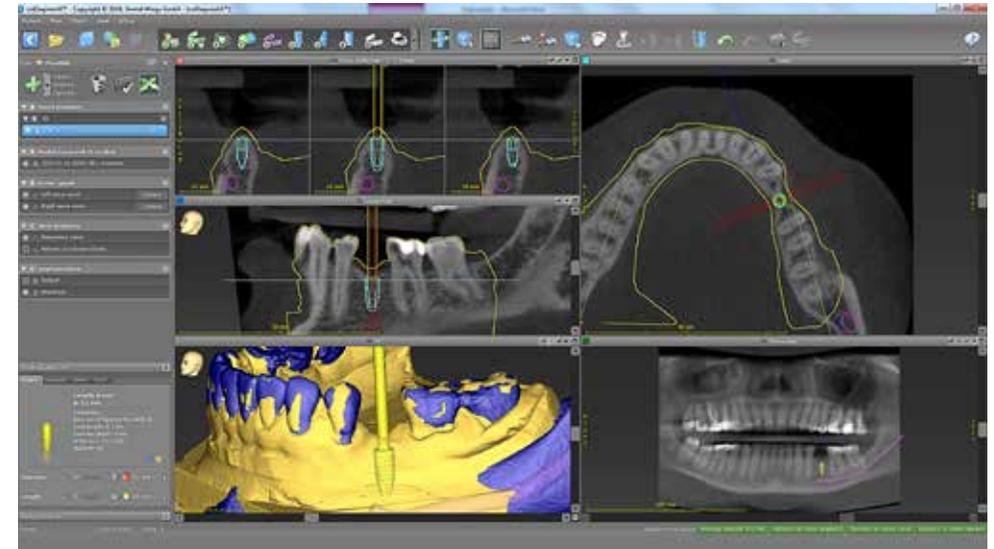
3D view representing DICOM images in blue and STL stained in yellow.



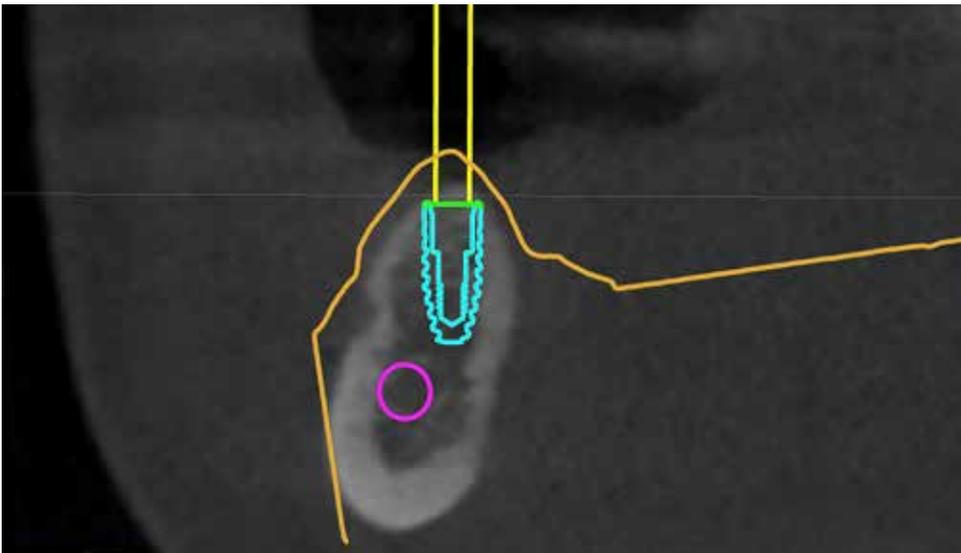
The interface of the coDiagnostics™ software allows viewing multiple windows or the selection of each view independently.



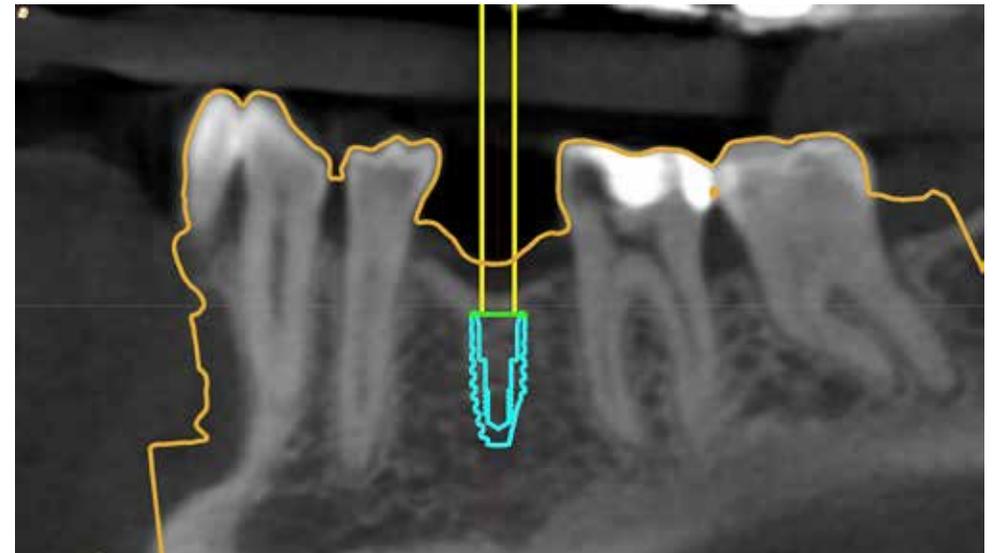
The next step is to plan the position of the implant. From the library of over 70 implant systems, you can choose the type of implant that best suits the anatomical conditions.



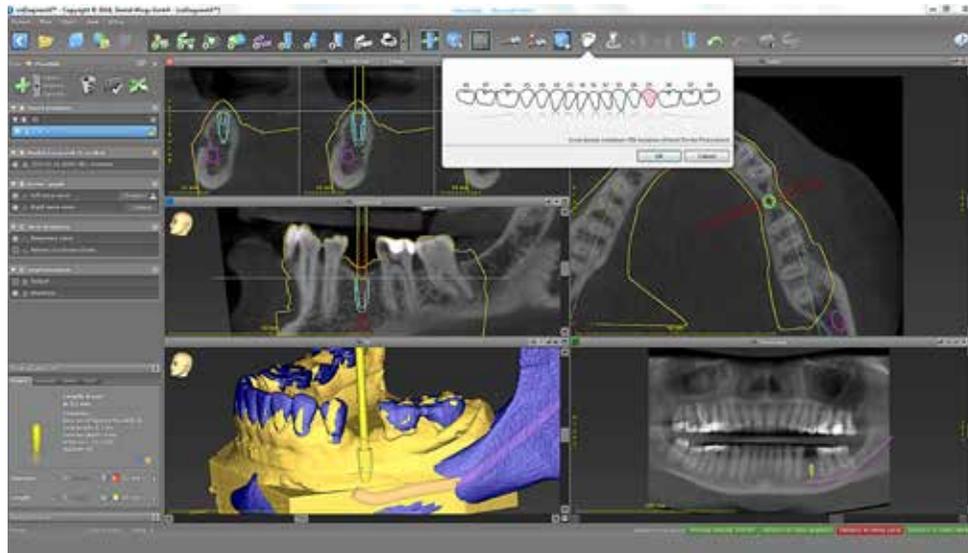
The implant will be automatically added to the selected place by the doctor. In this case, in the position of the missing second premolar in the left side of the mandible.



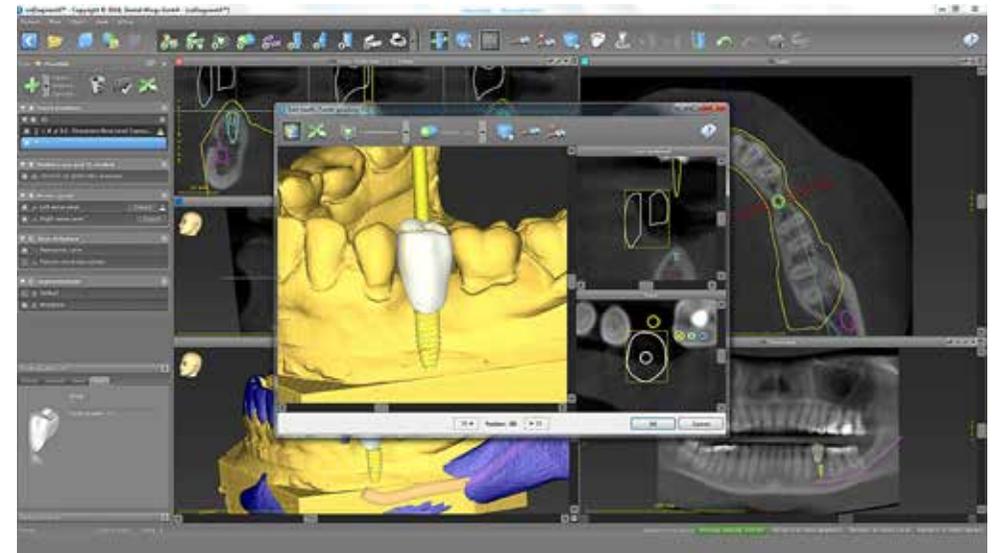
The image shows the planned implant in cross-section with the prominent position of the mental nerve (marked in pink) and the contour of the soft tissue.



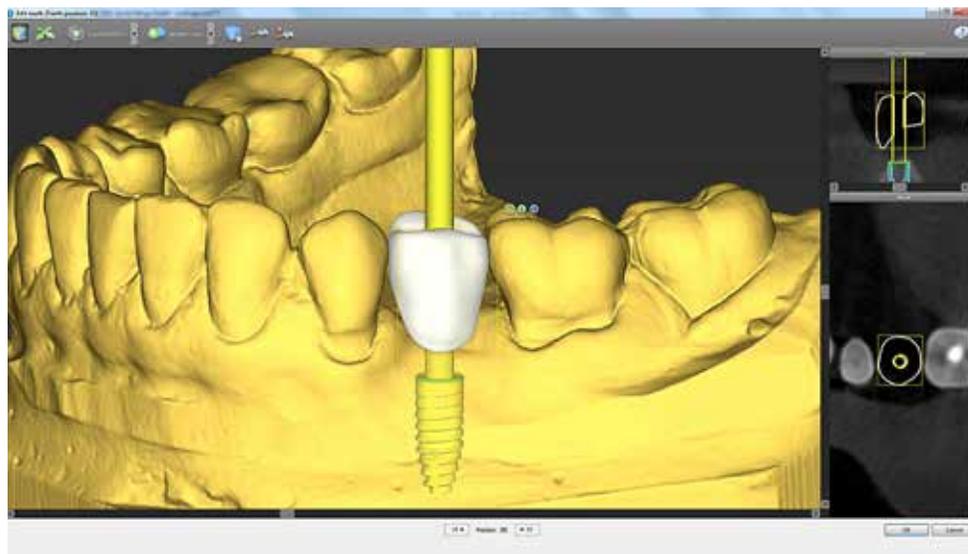
By rotating the image around the implant axis, it is possible to check the position of the implant relative to the adjacent anatomical structures and the roots of adjacent teeth.



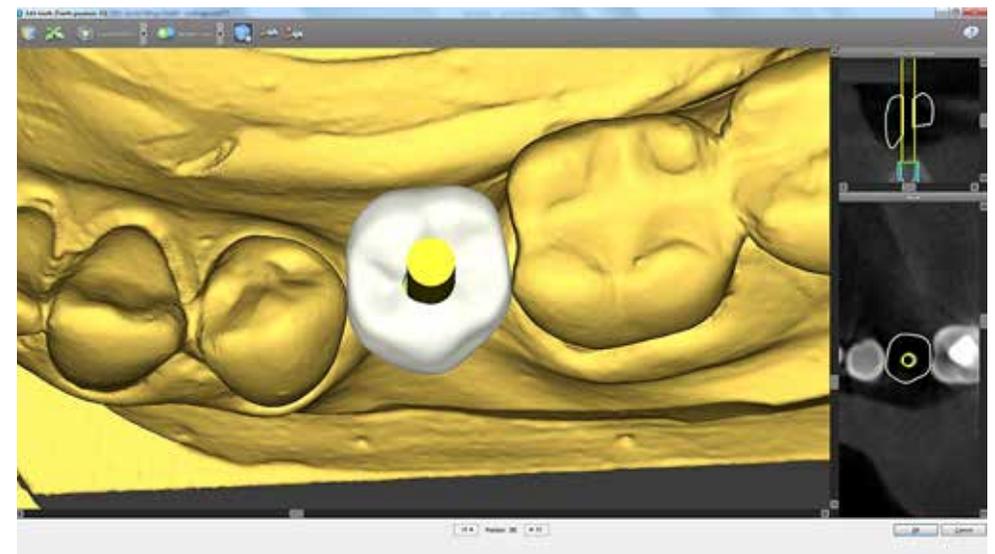
Implant axis can be optimized. The software allows the addition of the so-called "Digital wax-up." It is enough to choose the number of the missing tooth to add a virtual crown automatically.



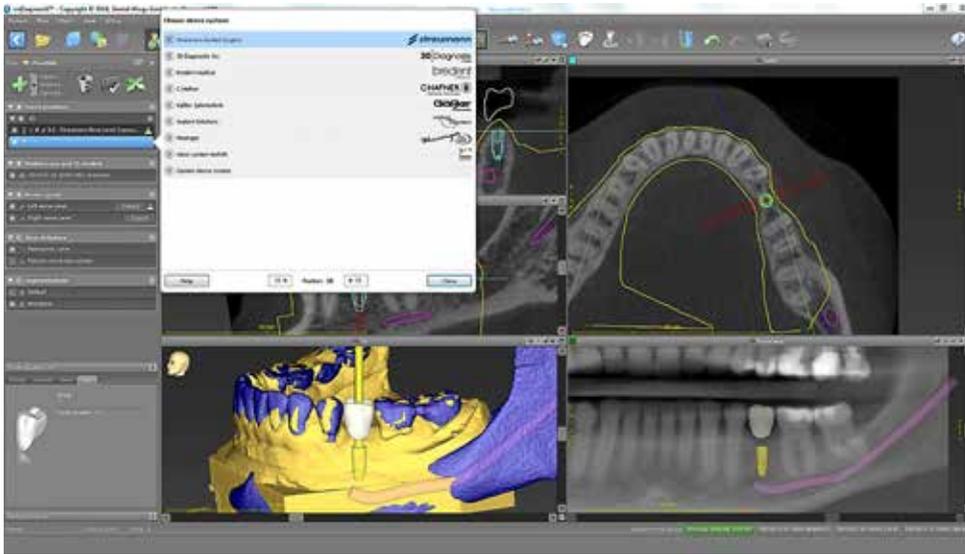
The shape and position of the tooth are editable. You can rotate it, change its size and location.



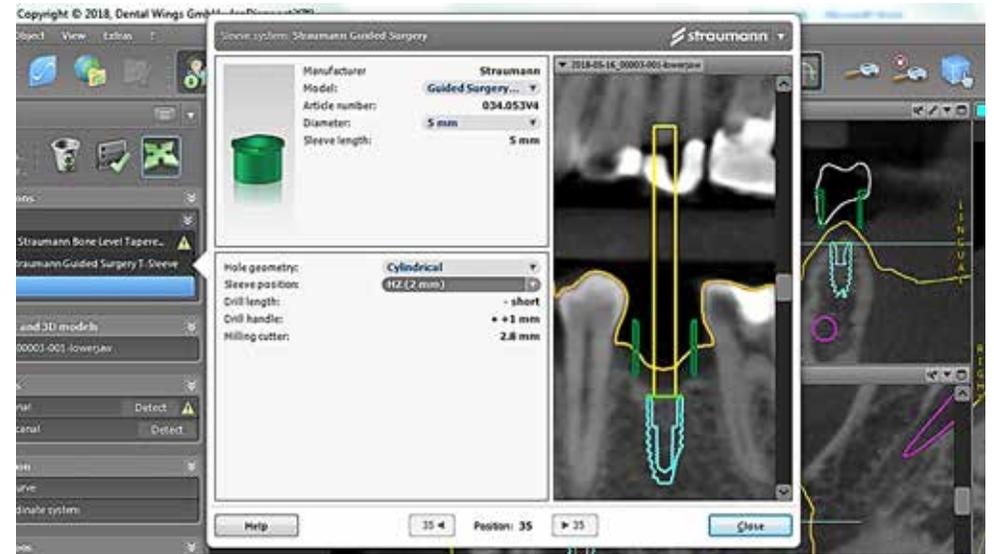
Editing and controlling the position of the tooth. In the upper right corner above the tooth, there are three small icons responsible for the function. The first is shifting, the second is the size change, and the third is responsible for the rotation.



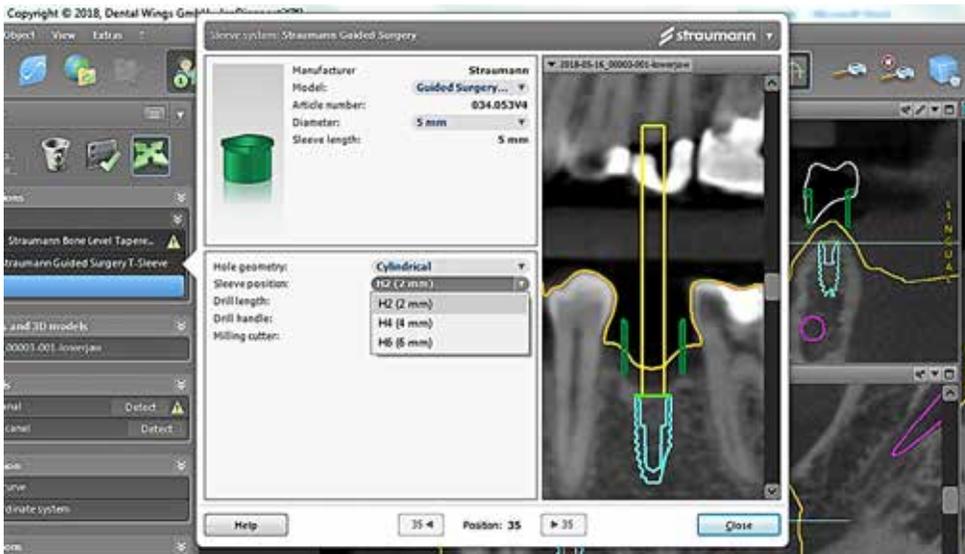
The ability to check images in various planes makes it easier to find the optimal position due to the prosthetic axis.



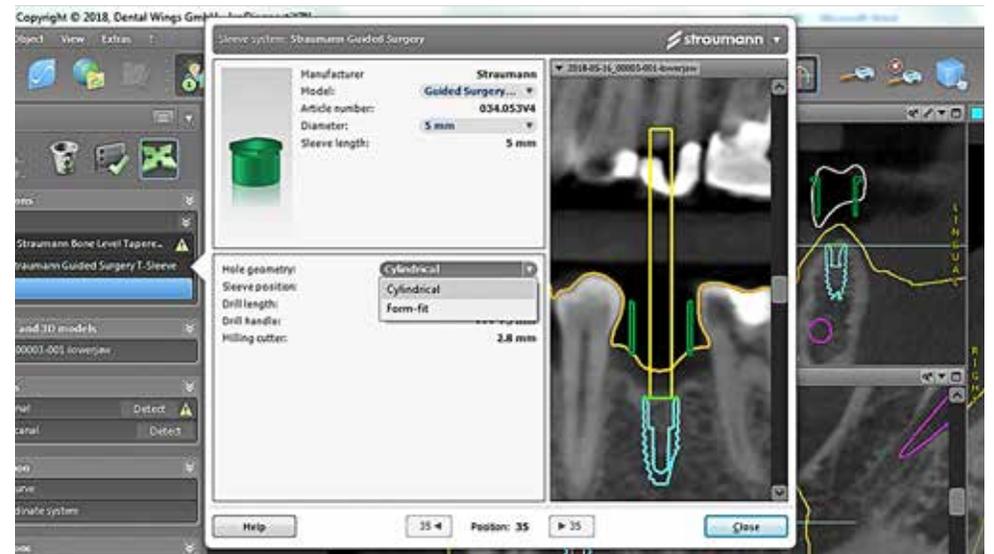
After planning the final position of the implant, you choose the type of computer navigation system or the availability of the third party sleeves available. The available options for a given system are visible in the drop-down menu.



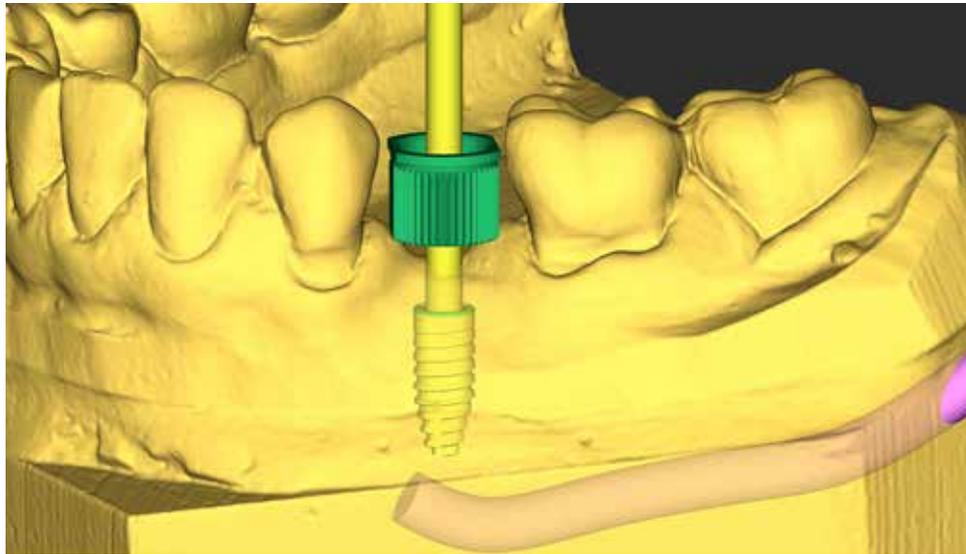
For Straumann implants, a list of available sleeves is automatically developed. The default sleeve for full navigation is a 5mm diameter sleeve. The product catalog number is also given.



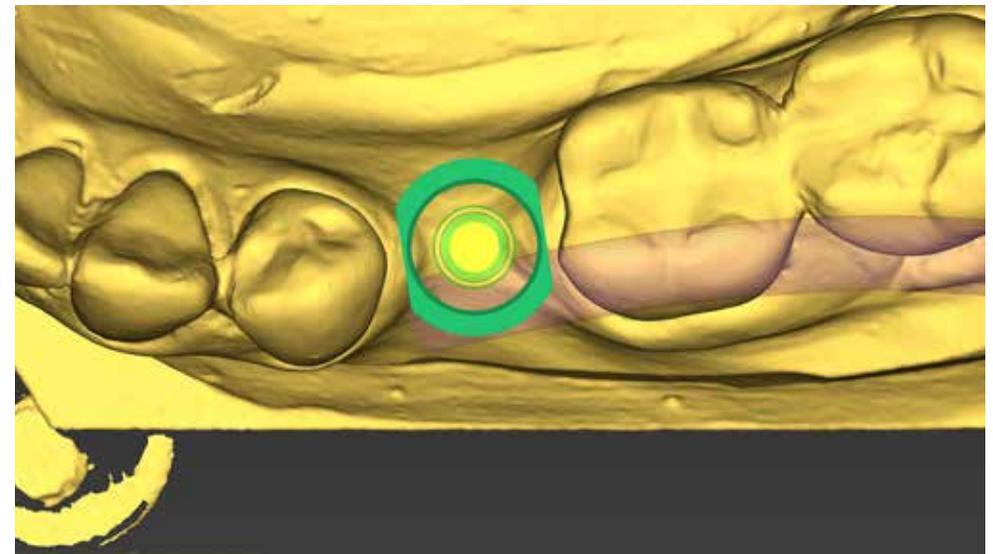
For Straumann navigation, the program allows selection of three positions of the sleeve relative to the implant platform. Position H2, H4 or H6 determines the distance between the base of the sleeve and the platform of the implant in mm.



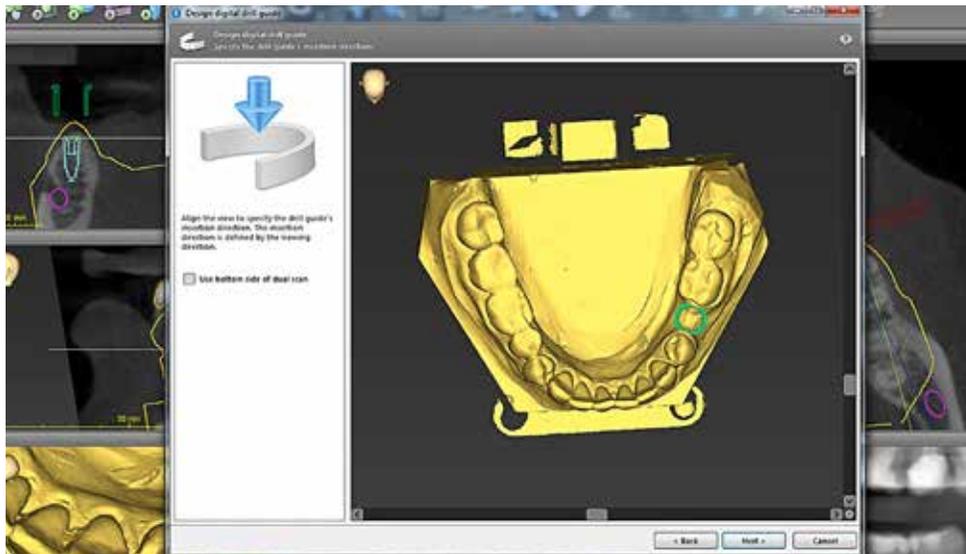
We also have the option of choosing the shape of the hole in the template for mounting the sleeve. It may be cylindrical or adapted to the form of the sleeve.



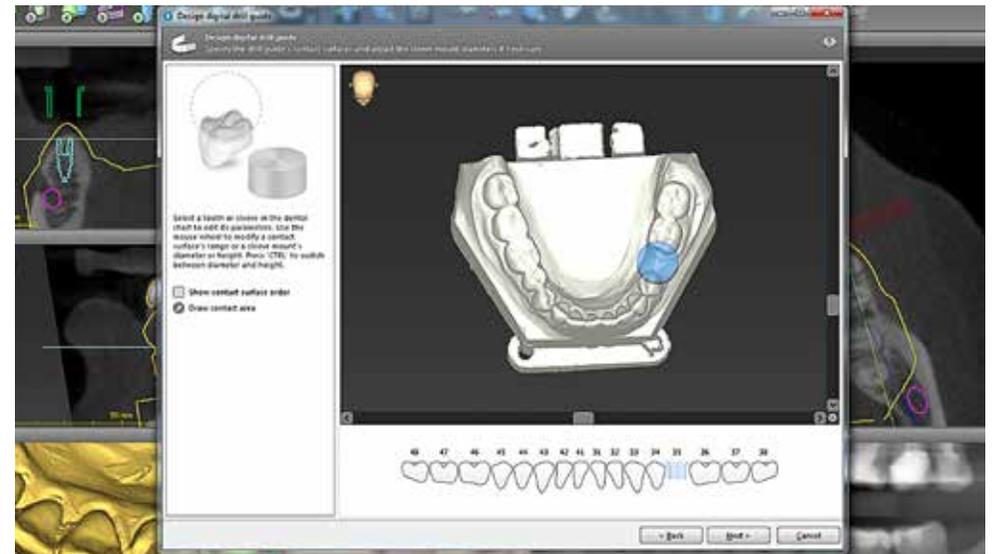
The position of the sleeve should take into account the thickness and arrangement of the soft tissues. Placed too low, it may prevent passive embedding of the template in its place due to the soft tissue.



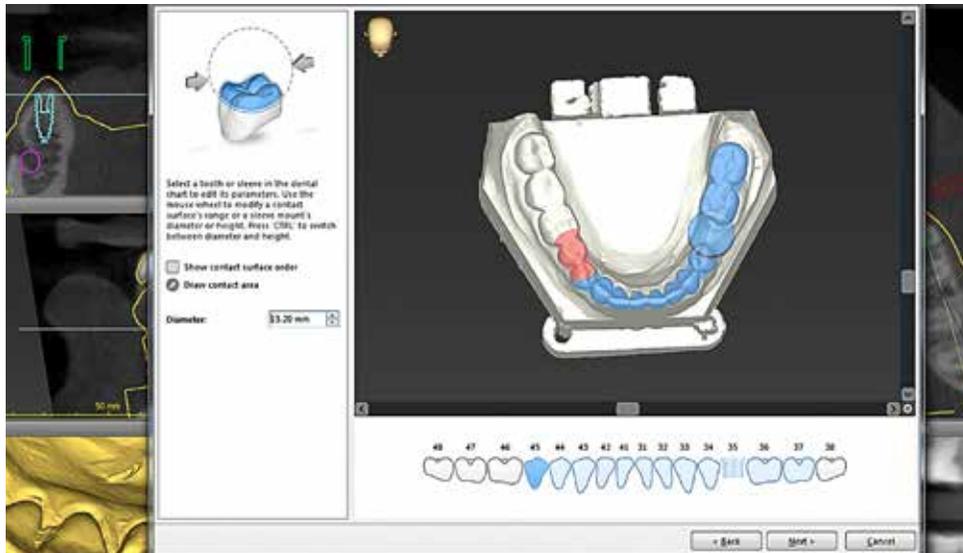
Make sure there is enough space between the teeth for the sleeve. If there is no space, change the diameter of the sleeve. There are three sizes: 5mm, 2.8mm, and 2.2mm



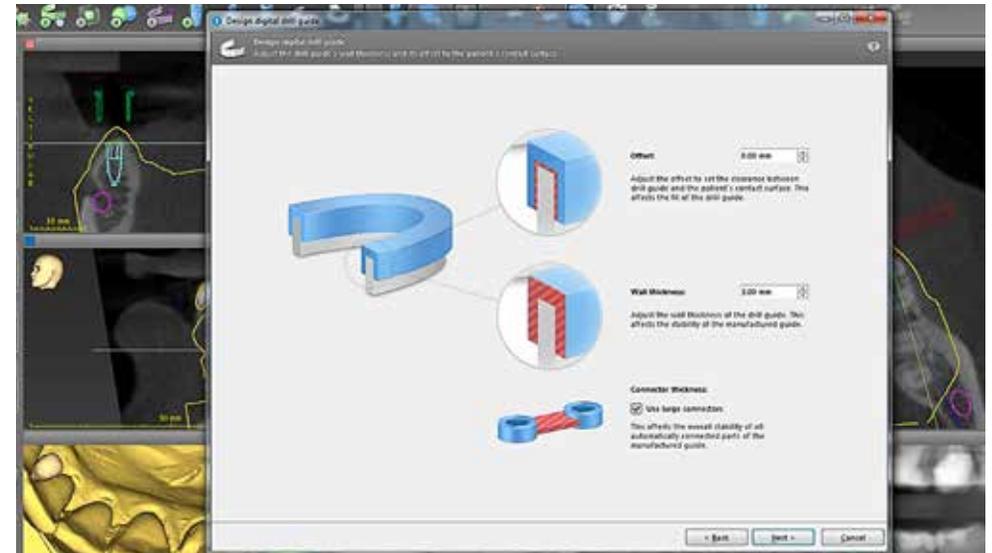
The design of the guide starts by specifying the drill guide's insertion direction. The viewing direction defines the insertion direction. All the undercuts will be blocked.



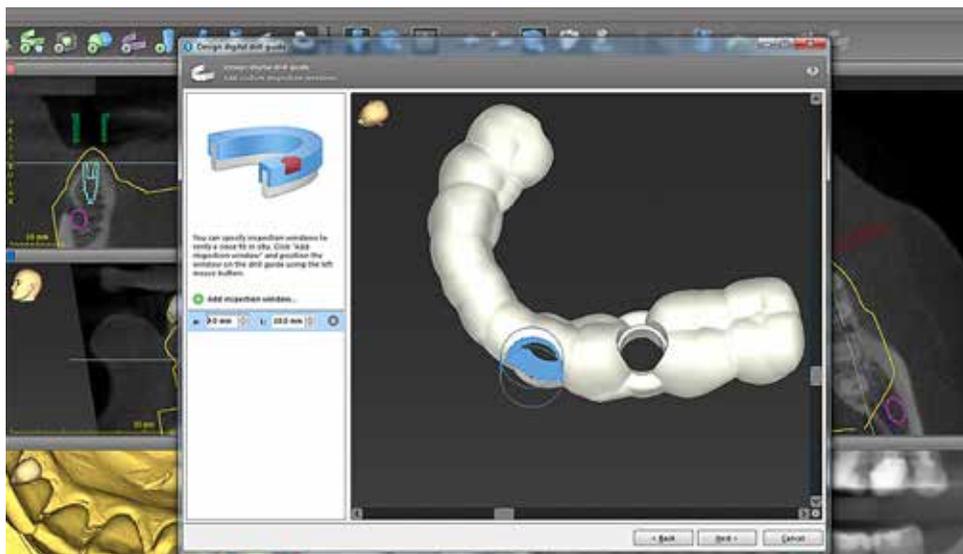
The position of the planned implant with the sleeve is automatically blocked and illuminated in blue. Select from the diagram the tooth positions which will give the support for the template.



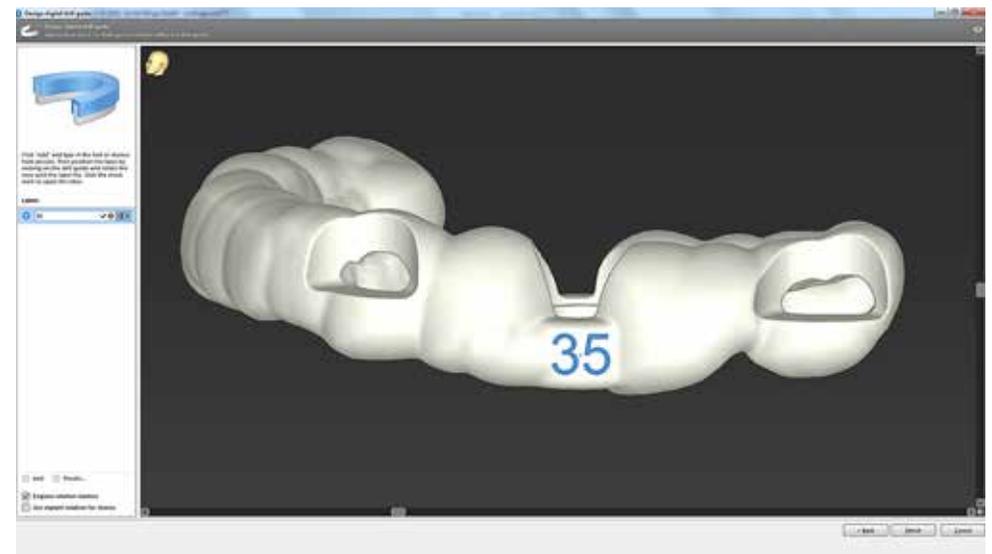
The size or span of the template depends on the position of the planned implant and the condition of the teeth.



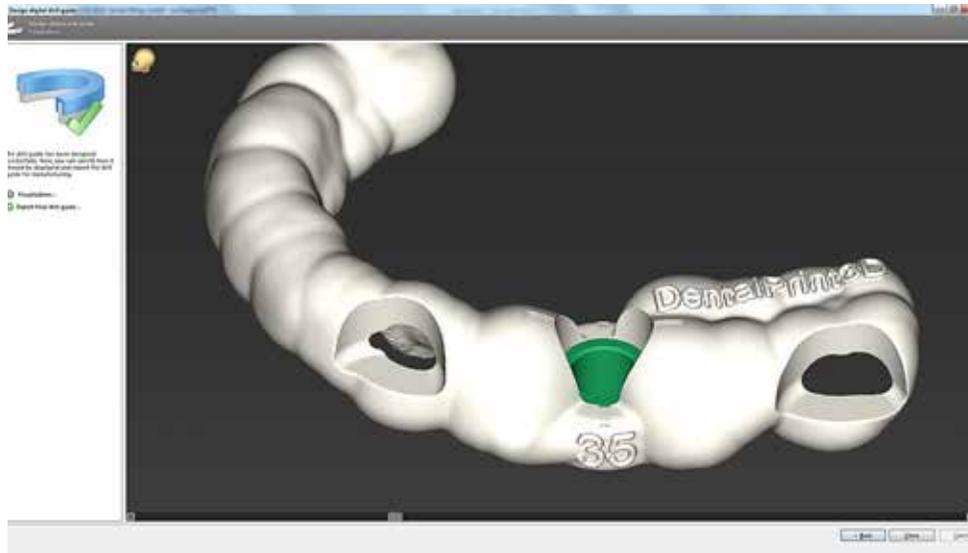
In the program, the user can specify the offset settings (clearance between the template and the teeth) and the thickness of the connectors. The offset settings depend on the printer type, type of support and template fixation.



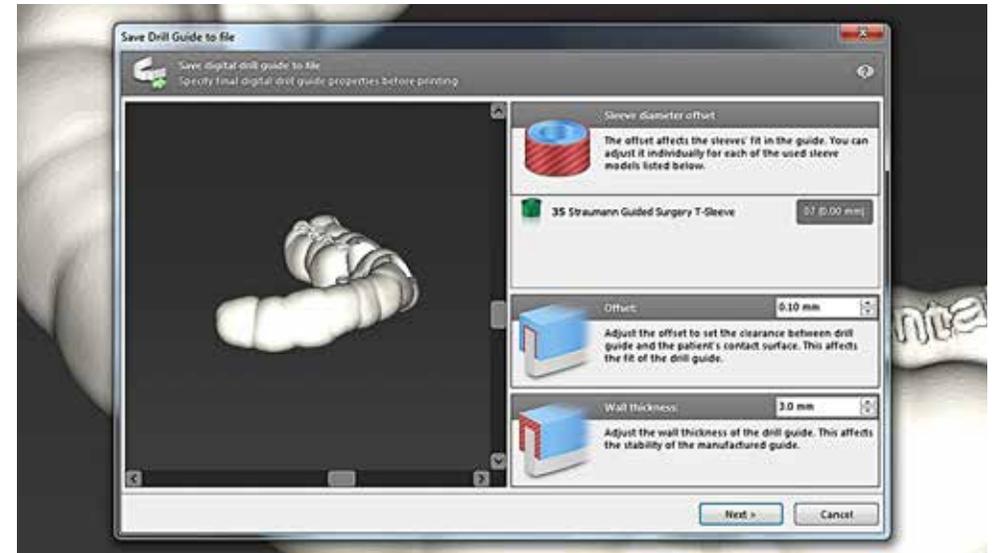
The software allows adding custom inspection windows to verify a close fit of the template on the teeth. Adding the windows needs caution to avoid weakening of the template construction.



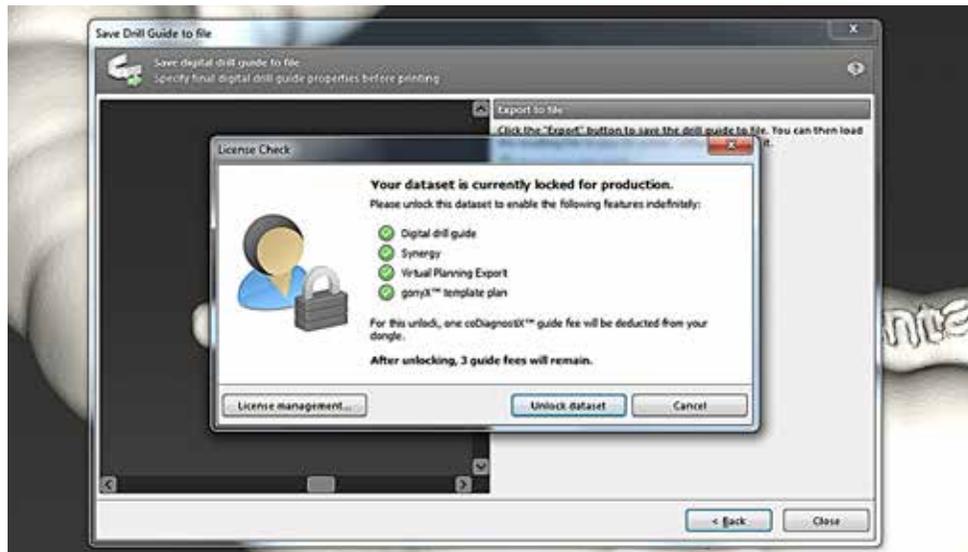
The template labeling is with individual information like patient data, tooth number, a number identifying whether the name of the clinic or doctor's details.



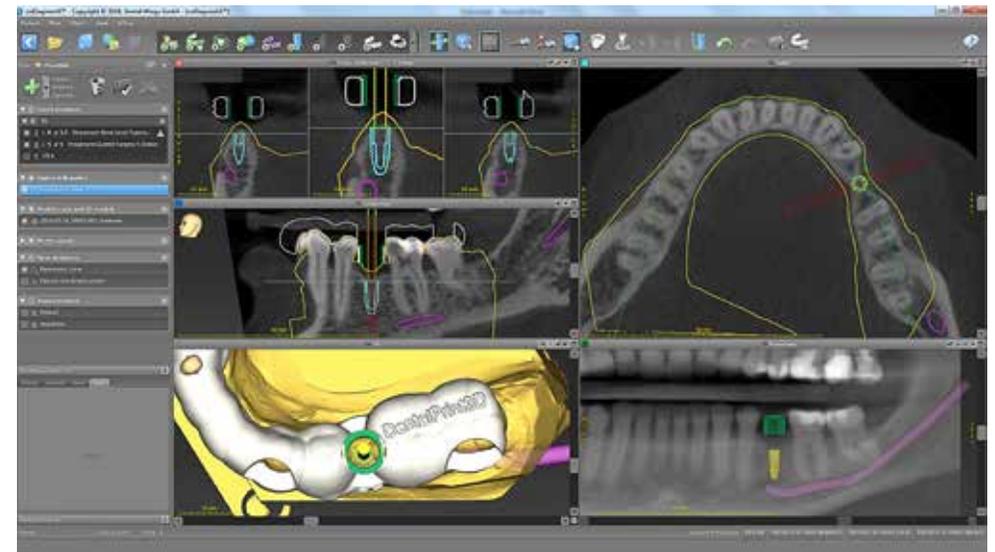
In a short time, the program generates a template, the design of which can be viewed and inspected. In the producer version, the software makes it possible to export the template in the form of an open STL file.



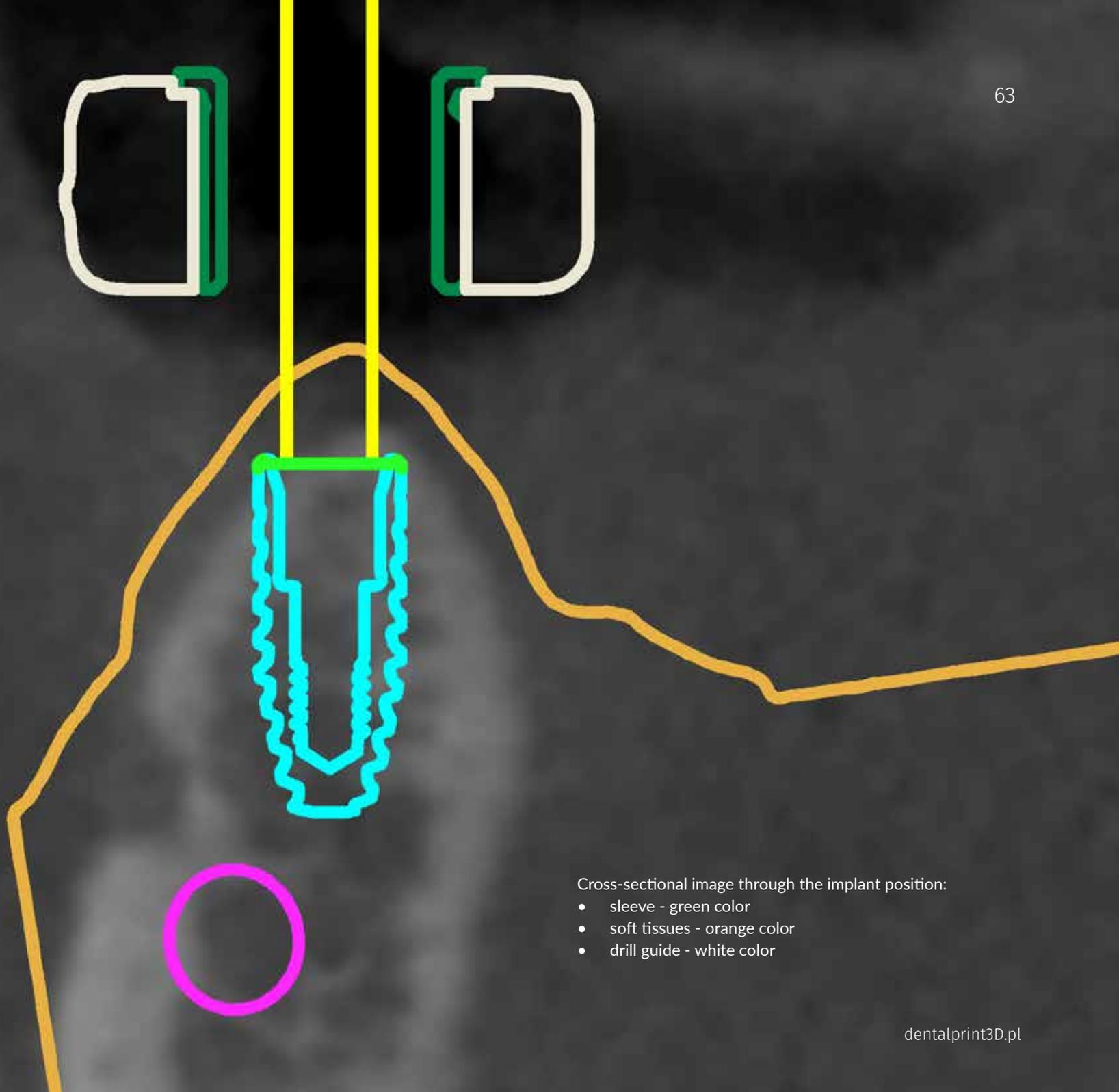
Before exporting, the program allows you to once again check the settings related to the production of a template such as offset or wall thickness.



The program will automatically collect the fee for the export of the STL file from the user's account, at the same time informing about the amount of remaining credits.



The STL file can be sent to the production of a template for guided surgery, while in the program we get an additional layer with the drill guide.



Cross-sectional image through the implant position:

- sleeve - green color
- soft tissues - orange color
- drill guide - white color

Merging data

For edentulous cases with Dual Scan Technique

The integration of DICOM and STL files in edentulous cases requires the presence of additional reference points, which are, for example, radiological markers. The most straightforward technique for obtaining data for integration is the Dual Scan technique. As a result of this approach, we get two DICOM datasets.

1. The first set of data are DICOM images of a patient with a radiological template in the mouth during the examination.



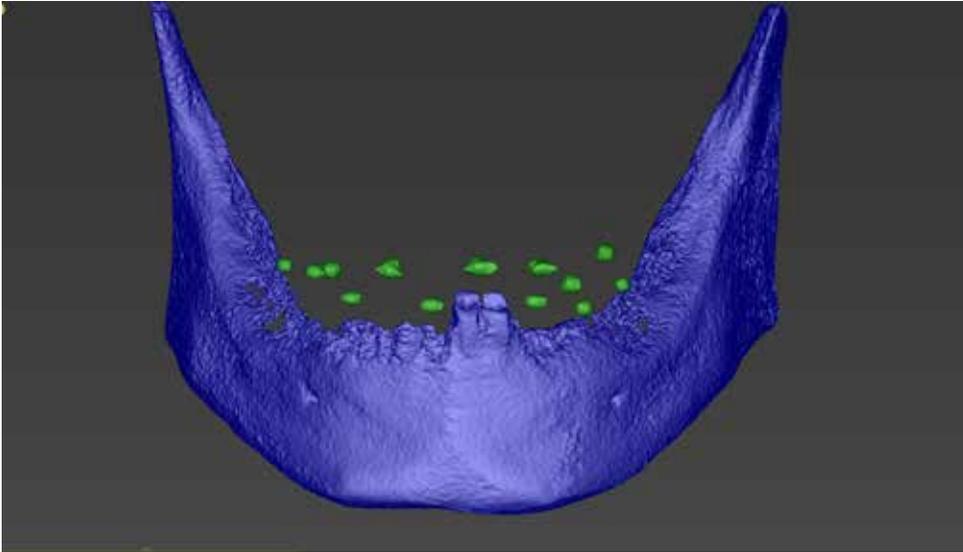
3D reconstruction obtained on the basis of the CBCT examination with a radiological template in the dual scan technique.

2. The second set of data are DICOM images obtained from the second CBCT examination of the prosthesis itself. In order to create a surgical template, the coDiagnostiX™ software will use the negative image of the denture base, which is a copy of the soft tissues in the mouth.

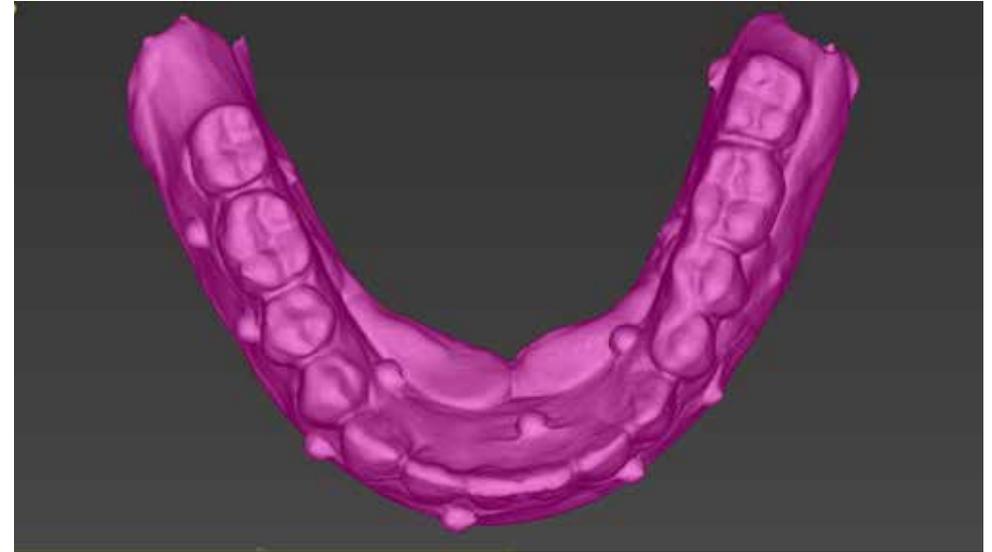
This technique requires that the denture does not have any metal elements and radiographic markers should have a higher radio-opacity than the prosthesis acrylic material.



3D reconstruction of a radiological template being a copy of the lower prosthesis based on the second CBCT examination.



3D image after segmentation, which contains two color layers. The lower jaw is marked in blue, and the radiological markers are stained in green.



3D reconstruction of the lower denture after segmentation and dying in pink. The radiographic markers protruding beyond the outline of the prosthesis are visible.

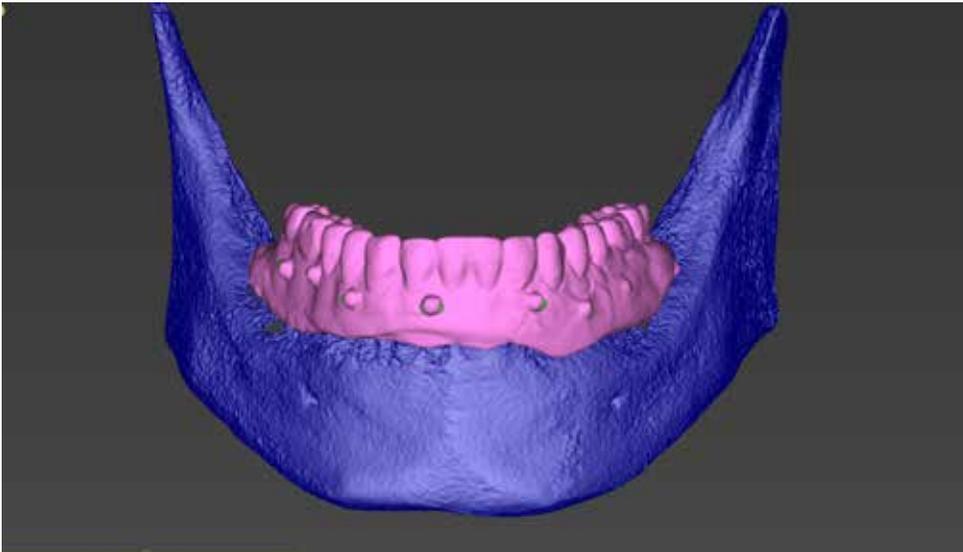
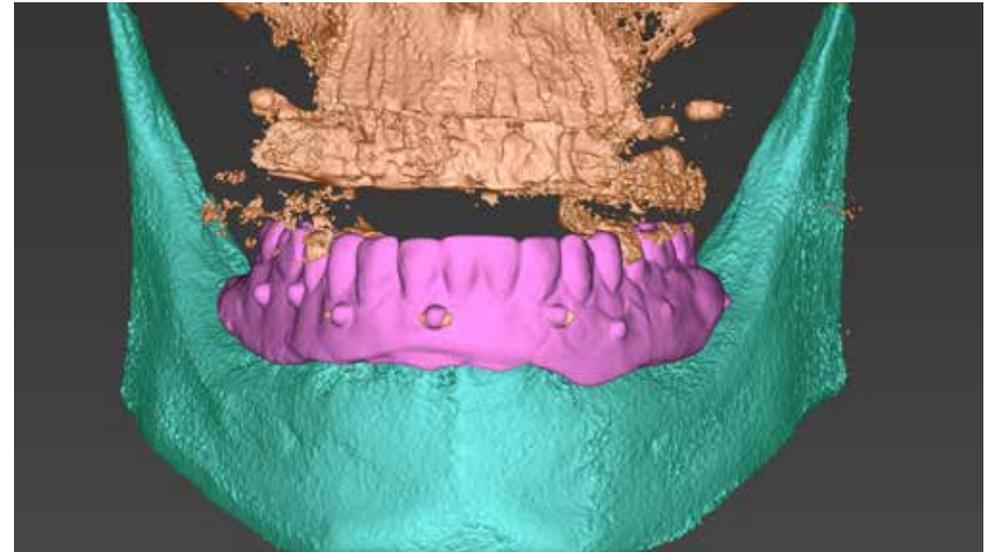
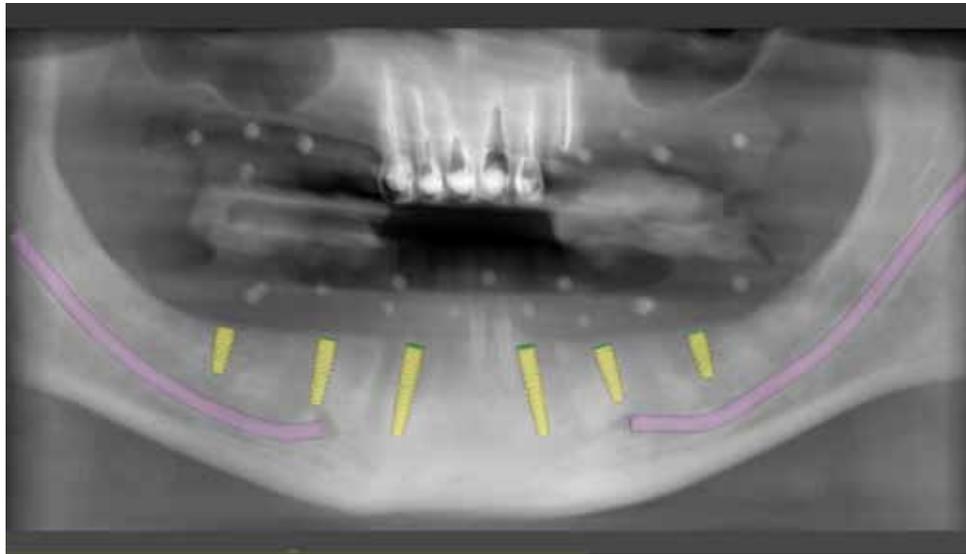


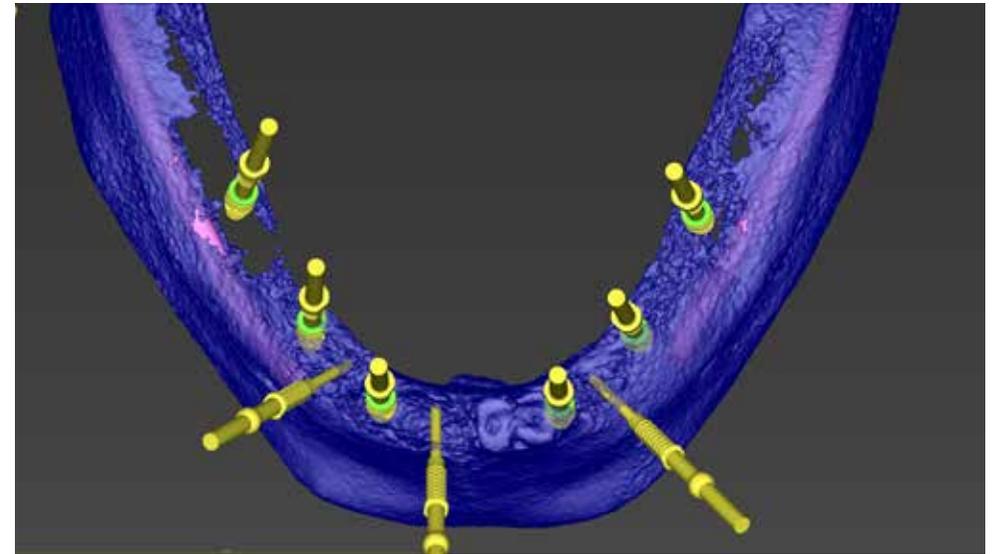
Image after integration of DICOM files. Two independent images were put together on the basis of common reference points and a precise algorithm in the coDiagnostics™ program.



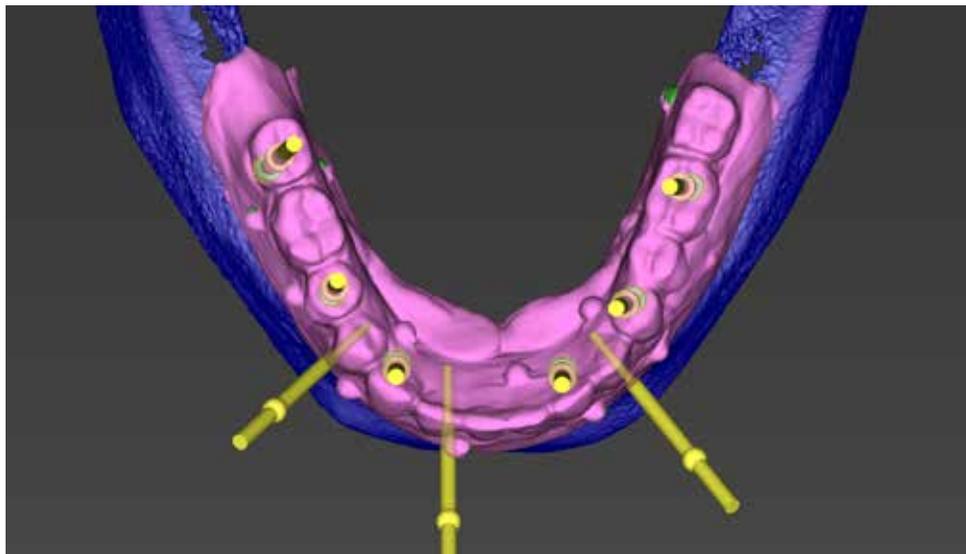
In the program, it is possible to enable and disable individual layers and color changes according to the user's preferences.



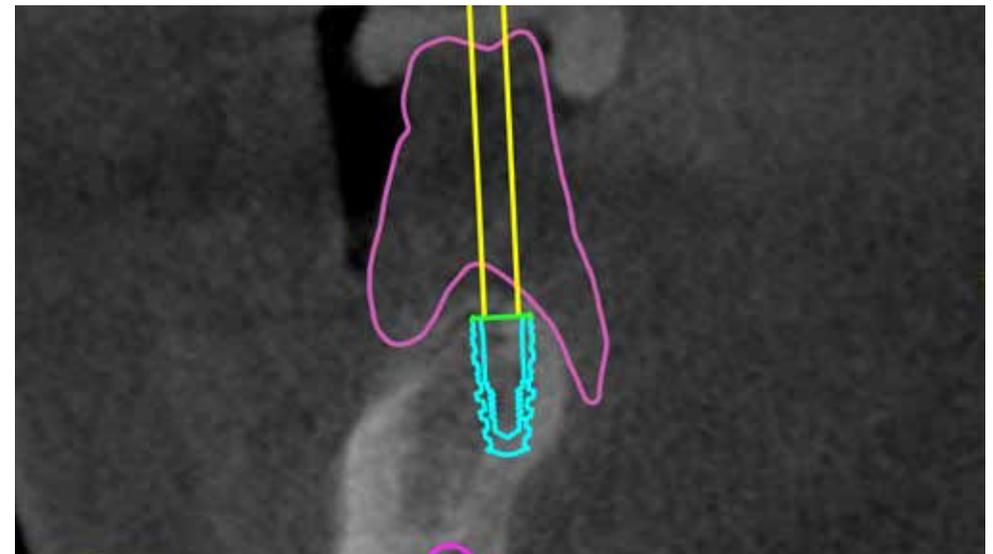
Implant planning starts with assigning their positions according to the diagram of the teeth – an example of planning the location of Neodent implants.



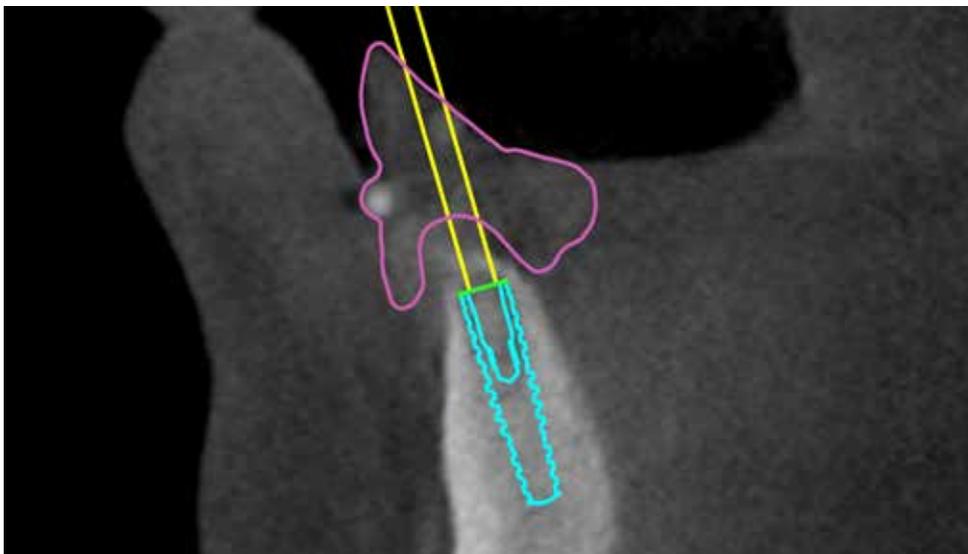
Implant planning and selection of positions for anchoring pins in the bone.



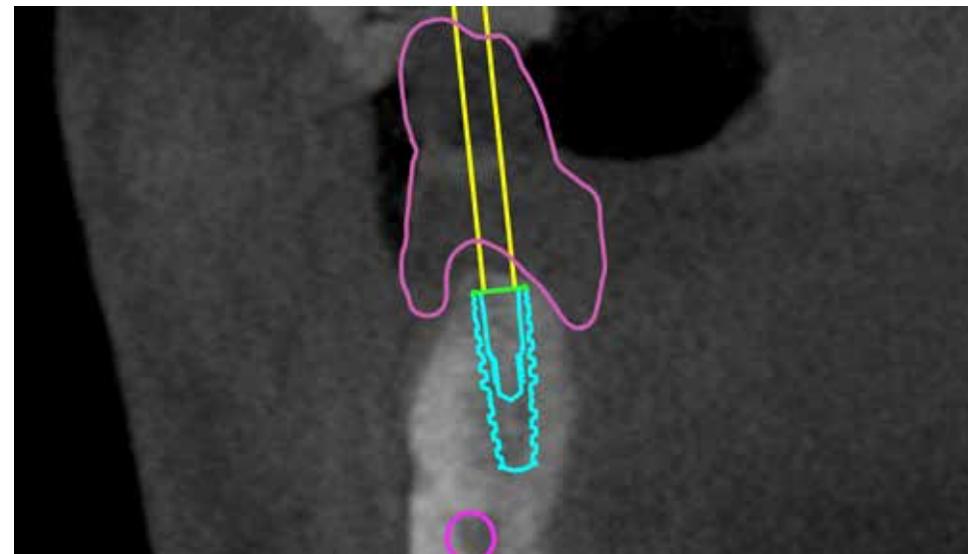
Verification and optimization of implant positions in relation to the position of the teeth in the radiological template.



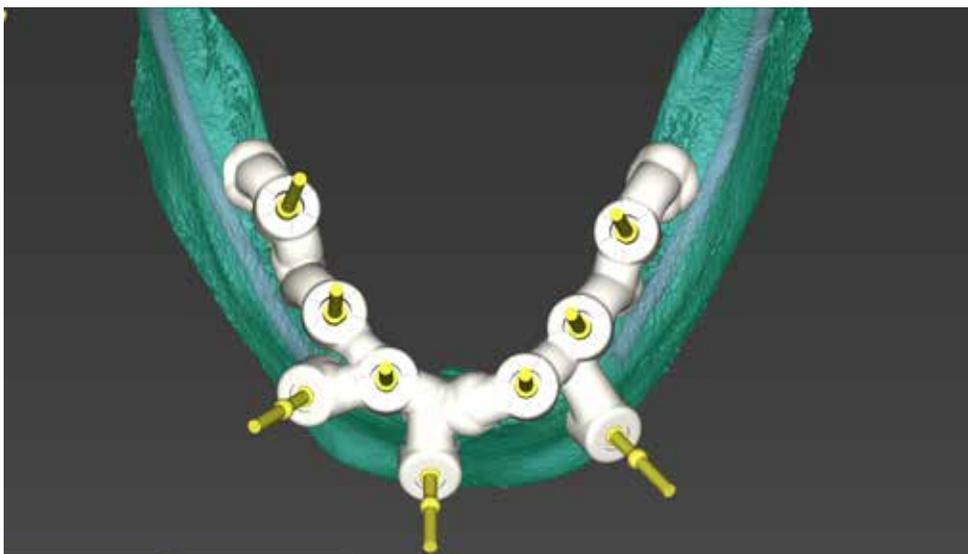
Information about the bone and the shape of the prosthesis will be visible on the cross-sectional images, allowing precise planning of the implant's position relative to the prosthetic axis and the thickness of the soft tissues.



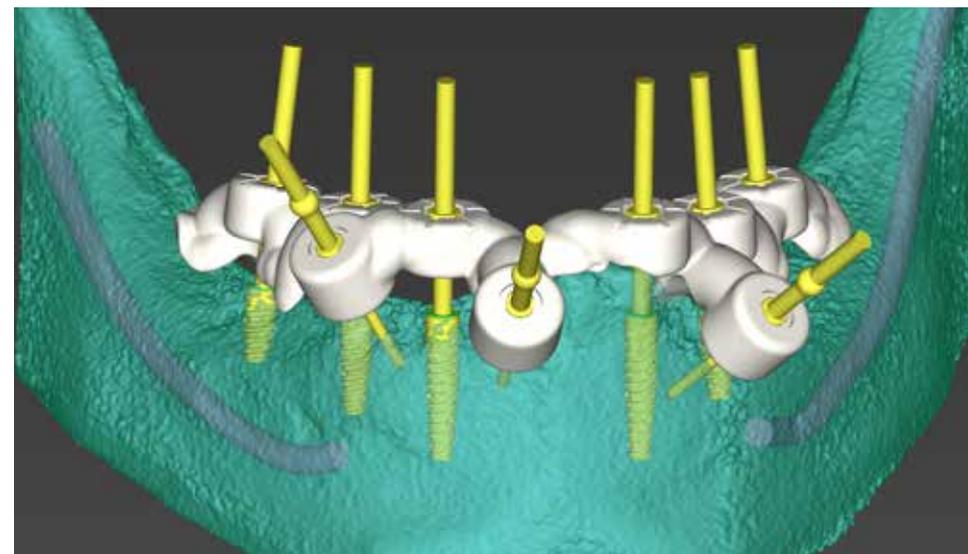
The cross-sectional view (32). The implant's setting axis allows access to the occlusion screw for prosthetic work in the optimal place from the lingual side.



The cross-section in the position 44 - the optimum position is also achieved within the premolars.



Design of the template for osteotomy with pilot burs. The guide is with distal support on the bone in the molars region and stabilization with three bone pins in the front of the mandible.



The designed template is visible with the implants and pins in their position. For the clinical procedure, it is necessary to embed in the guide the dedicated sleeves for drills guidance. Here are visible in yellow.



Guided Surgery





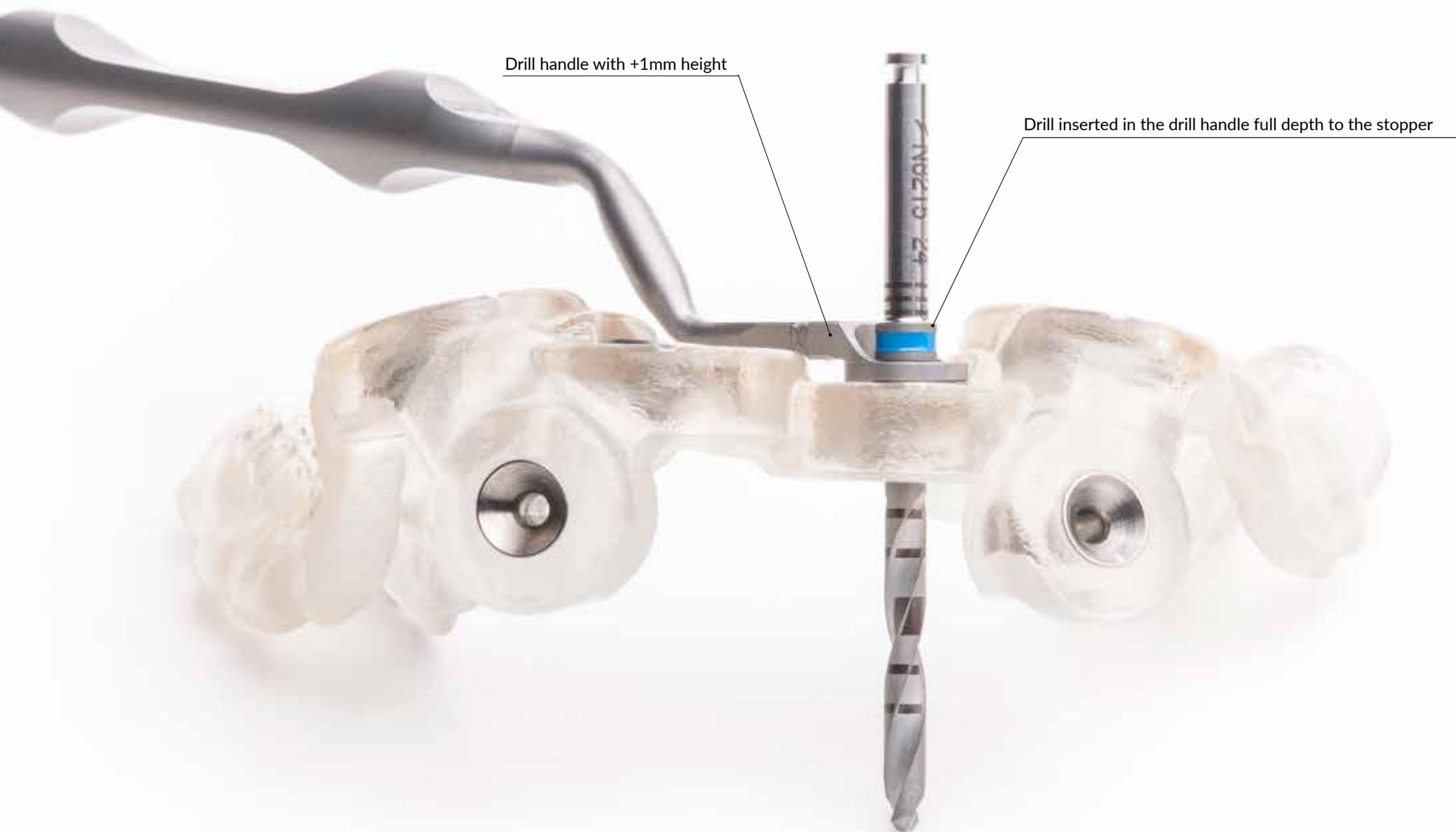
Drill holders for Straumann Guided computer navigation system.

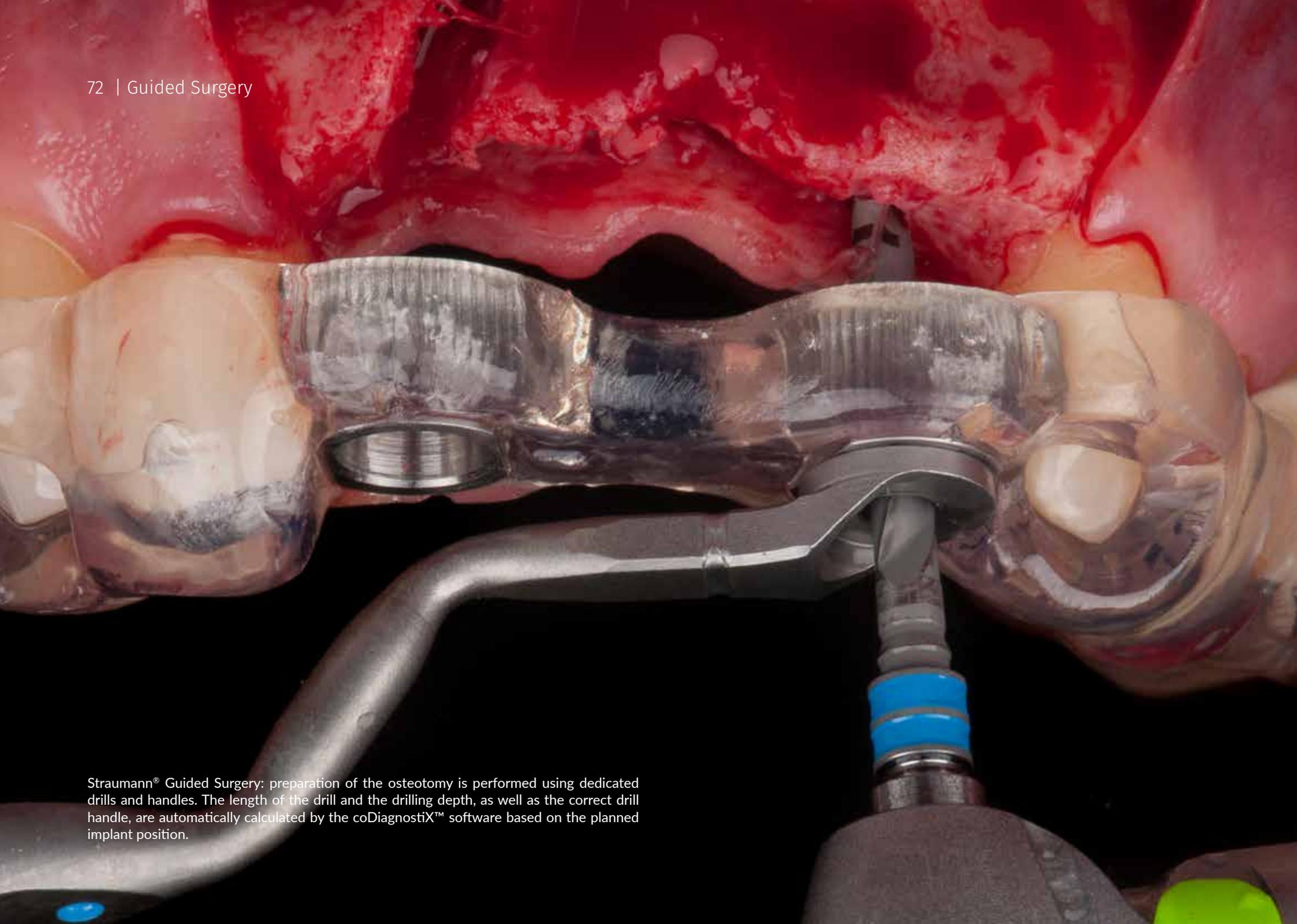
Straumann® Guided Surgery concept



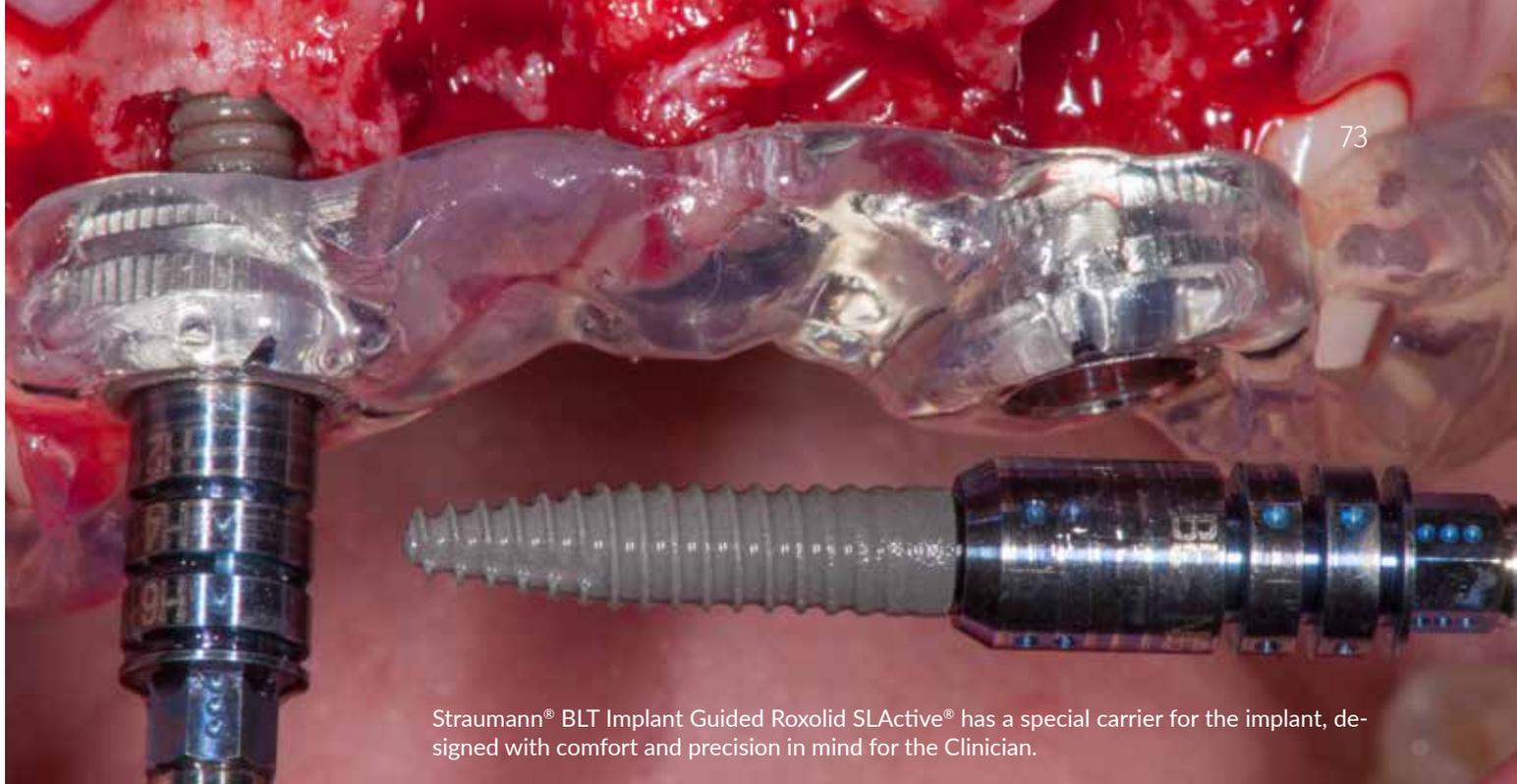
Straumann® Guided Surgery concept is based on the sleeve-in-sleeve concept.

- The cylinder of the drill handle is inserted into sleeve fixed to the surgical template.
- For each instrument diameter, an ergonomic drill handle is available.
- Every drill handle features one cylinder with an additional height of +1 mm at one end and a second cylinder with an extra cylinder height of +3 mm at the other end.
- For identification during surgery, Straumann® drill handles for guided surgery are color-coded and symbol-marked
- The surgical protocol lists which cylinder of the drill handle (+1 mm, +3 mm) should be used for each implant.





Straumann® Guided Surgery: preparation of the osteotomy is performed using dedicated drills and handles. The length of the drill and the drilling depth, as well as the correct drill handle, are automatically calculated by the coDiagnostiX™ software based on the planned implant position.



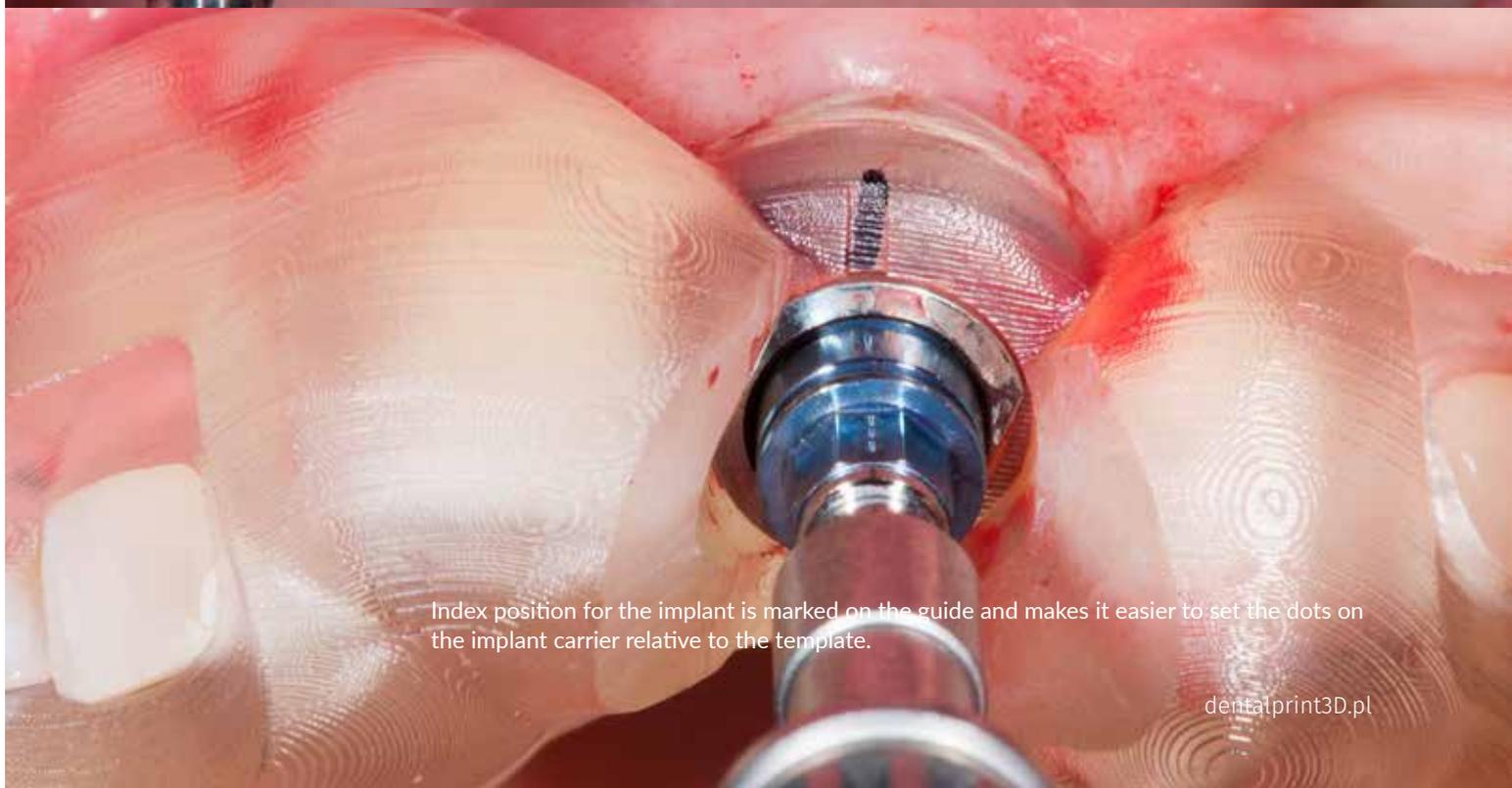
Straumann® BLT Implant Guided Roxolid SLActive® has a special carrier for the implant, designed with comfort and precision in mind for the Clinician.

FULL NAVIGATION

Implantation in full computer navigation makes it possible to perform a controlled osteotomy regarding depth, diameter, and the axis of the preparation and allows the implant to be inserted through the template, which guarantees the highest precision of insertion of the implant.

The most accurate programs allow you to plan a surgical template that takes into account the position of the index in the implant.

Kris Chmielewski, DDS, MSc

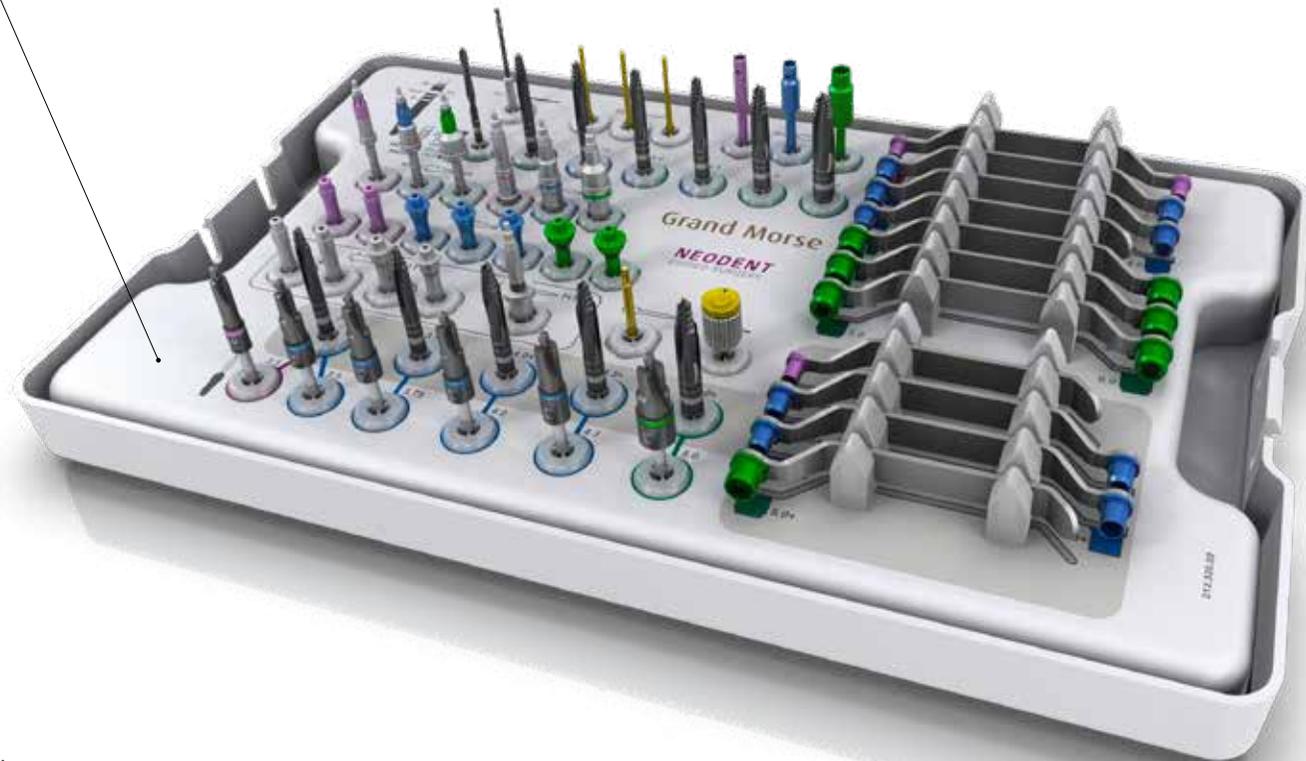


Index position for the implant is marked on the guide and makes it easier to set the dots on the implant carrier relative to the template.

Neodent® Guided Surgery

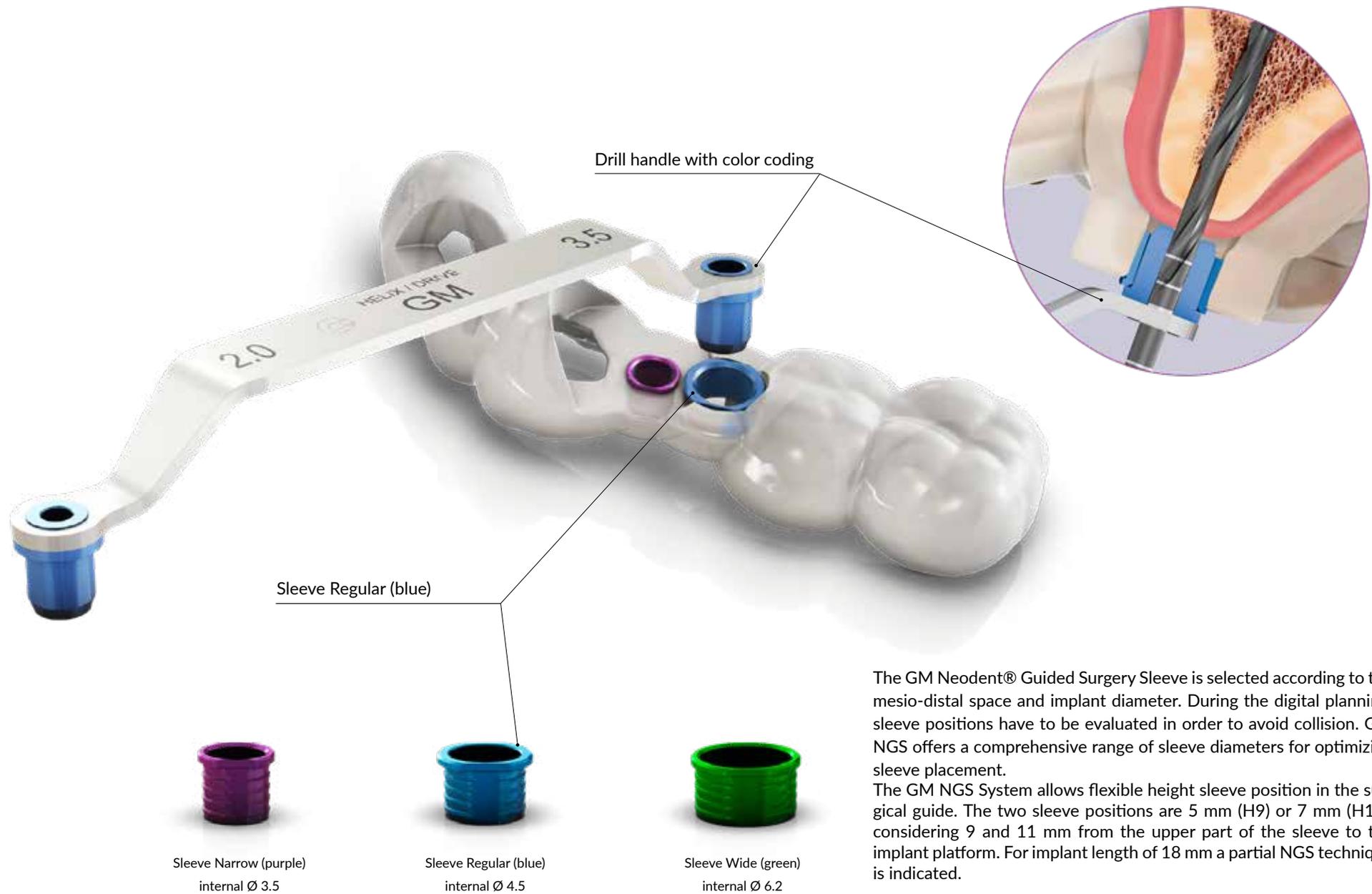


Neodent® Guided Surgery Kit for Grand Morse™



Neodent® Guided Surgery (NGS) Instruments

They are designed to prepare the osteotomy and perform the implant placement of Neodent® GM implants in combination with surgical guide including the Neodent® Sleeves.



Guides

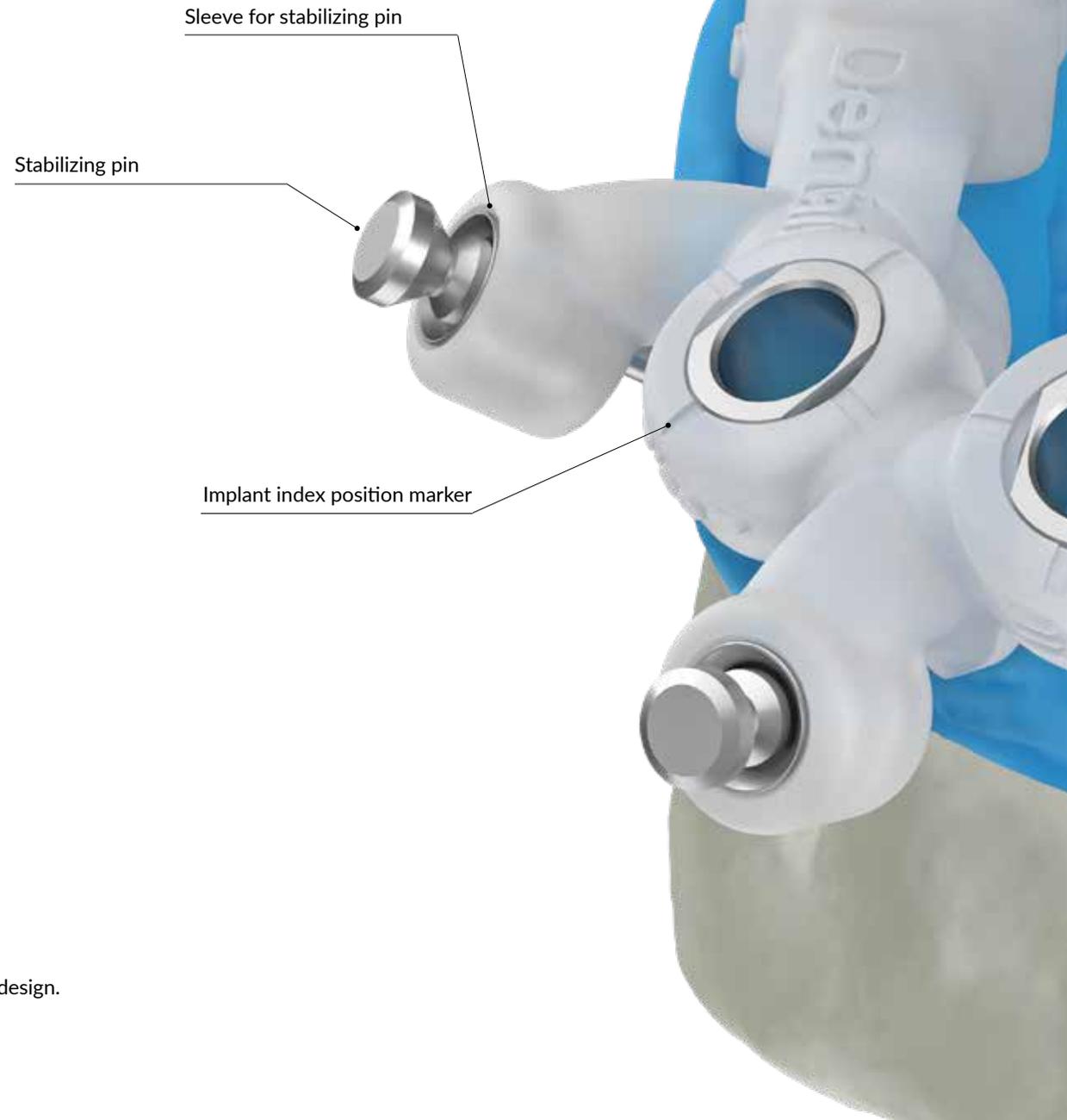


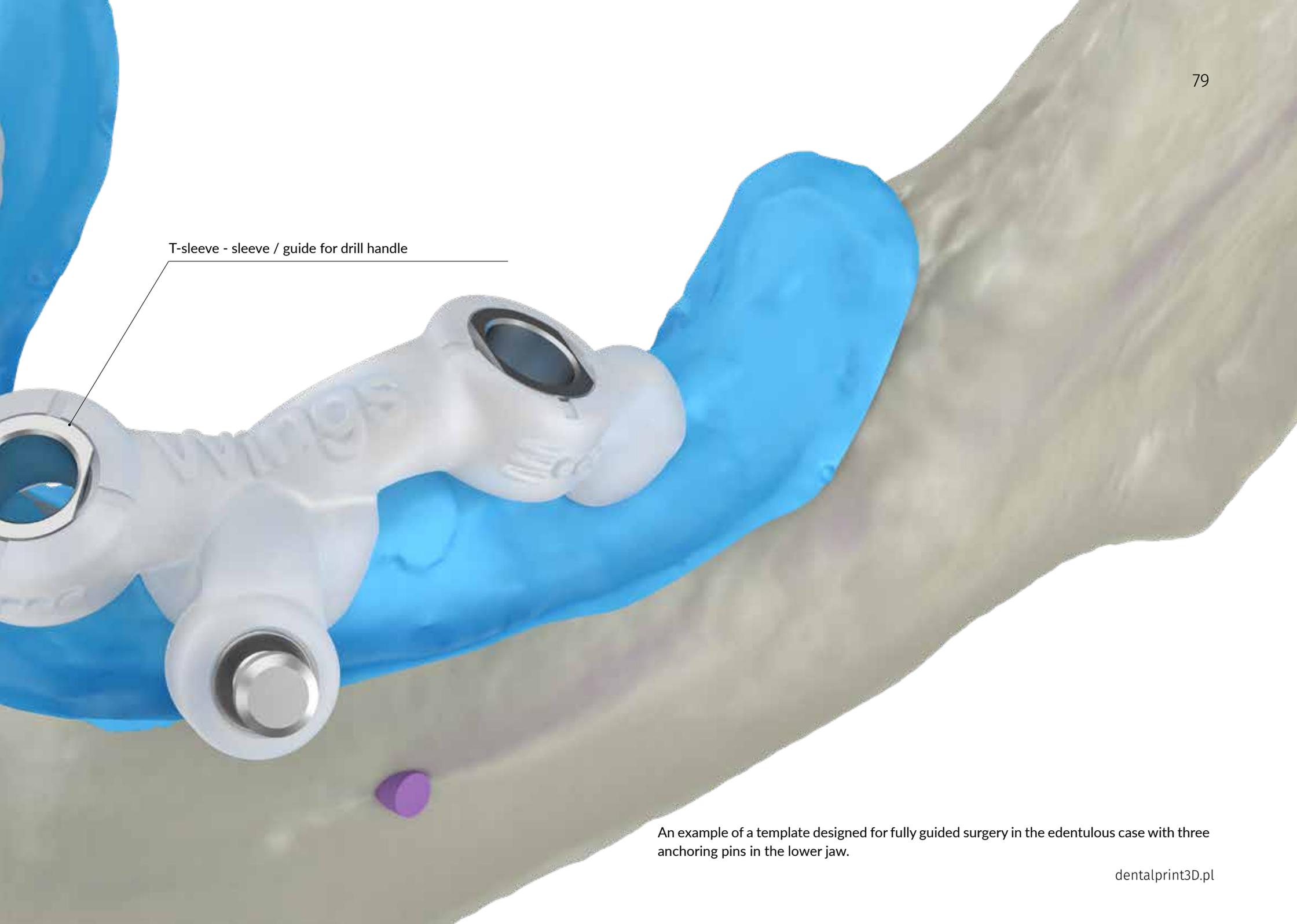
Guide Design

Many factors influence the design of a drill guide, including:

- The number of planned implants and their position
- Dental arch (maxilla or mandible)
- Type of support for the template (teeth, mucosa, bone, mixed)
- Type of retention (screws, pins)
- Indications (immediate, late implantation, bone reduction)
- The capabilities of planning software
- Technology of production (milling, printing)

Knowledge of the software and its functionality is the basis for optimal template design.





T-sleeve - sleeve / guide for drill handle

An example of a template designed for fully guided surgery in the edentulous case with three anchoring pins in the lower jaw.

Types of guides

For guided surgery

Definitions

Guides can be divided into two main groups due to their function:

- Guides for incomplete and complete osteotomy
- Guides for incomplete and full navigation

Guides for the osteotomy.

They are used only for a navigated bone preparation with dedicated drills. Templates can be prepared for pilot drills only or any diameter of the used drill. It is recommended that the guide for the drill in the template is made of metal. For this purpose, dedicated metal sleeves are used, which are fixed in the template. The lack of a sleeve poses a risk of introducing scraps of material from which the template is made to the wound during the preparation.

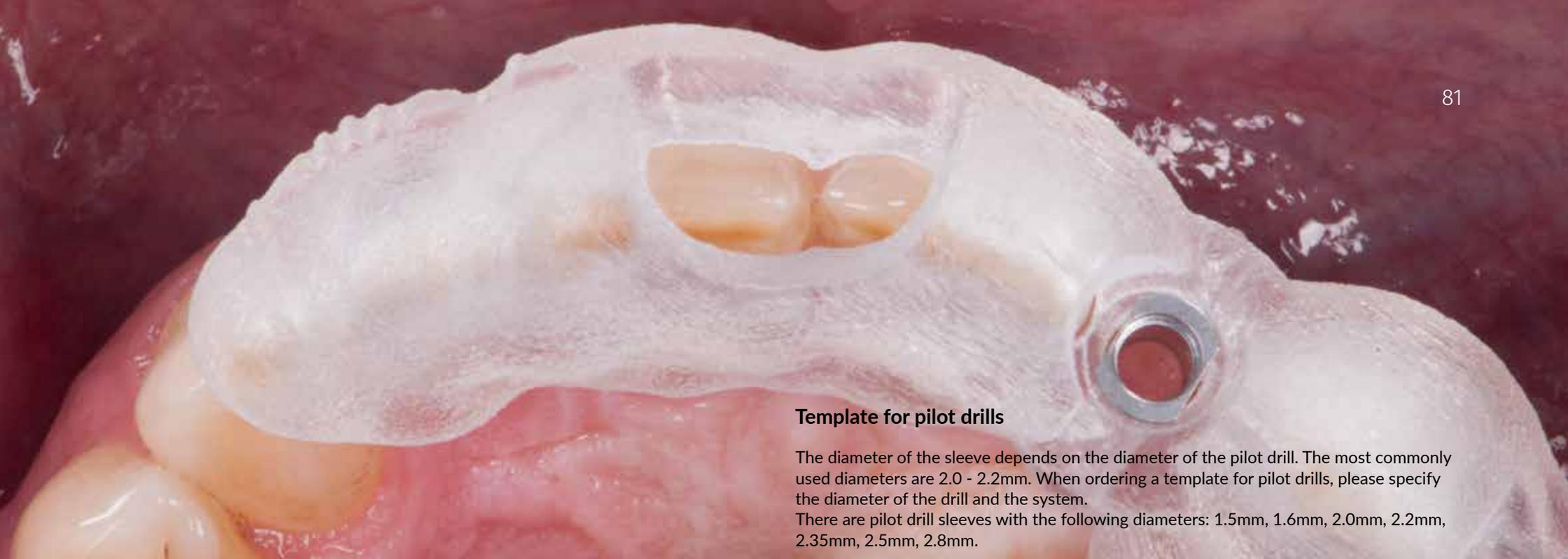
The disadvantage is the need to create a separate template for each drill diameter or use the unique sleeve-in-sleeve system. These types of guides will not allow the implant placement through the guide.

Guides for the fully guided surgery.

The incomplete navigation consists in performing a full osteotomy through the template, but the implant is placed without the guide. **Full navigation enables the preparation of the bone bed and insertion of the implant through the guide.** At the site of the planned implant, the template has a hole with a diameter of 5 to 7mm, depending on the system through which the bone preparation takes place. The drills or drill holders with a diameter fitted to the hole in the template will be used to prepare the osteotomy. Such systems also enable additional preparation with profile cutters on the ridge or tapping of the bone in the dense bone cases. The implant is inserted with the dedicated carriers after the osteotomy is completed. The advantage of such system is the exact preparation of the bone bed regarding axis, depth and spatial position, and the insertion of the implant, taking into account the location of the implant index (connection position for the abutment).

The template for full computer navigation is usually equipped with metal sleeves embedded in the guide. There are also sleeveless systems. In such a case the drills are equipped with the shank diameter fitted to the template hole diameter.

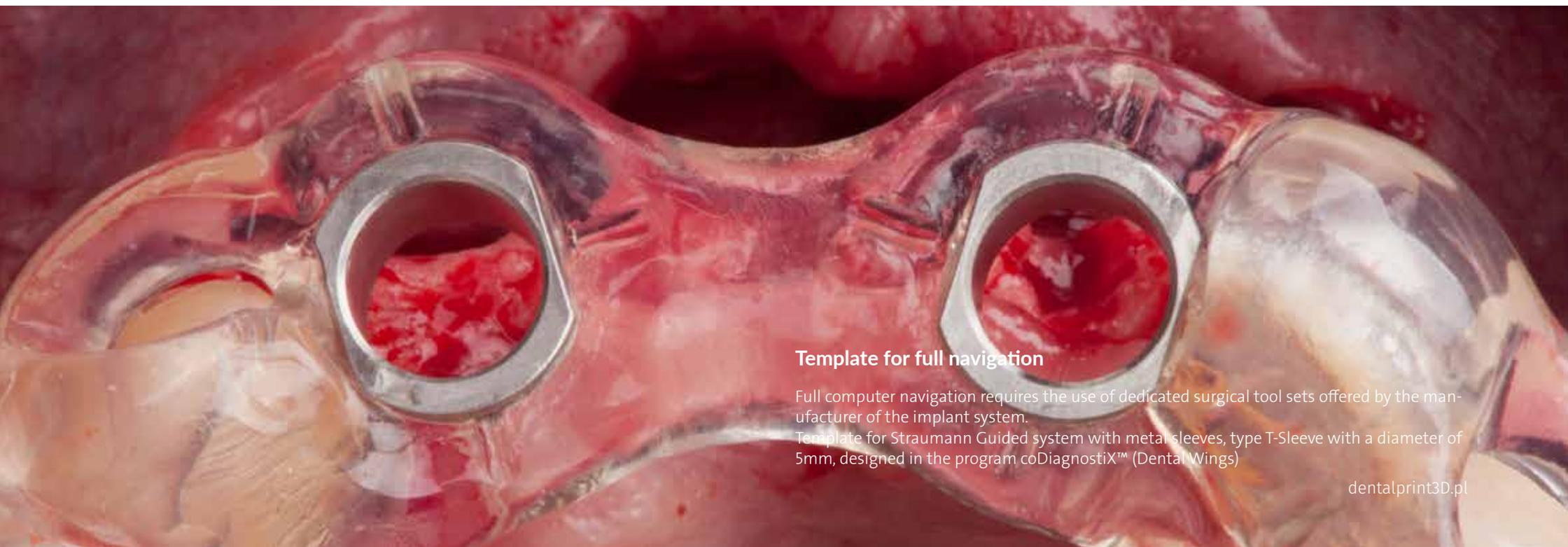
The template, depending on the implant system to be used, may be equipped with markers allowing for accurate orientation of the implant index position relative to the prosthetic abutment.



Template for pilot drills

The diameter of the sleeve depends on the diameter of the pilot drill. The most commonly used diameters are 2.0 - 2.2mm. When ordering a template for pilot drills, please specify the diameter of the drill and the system.

There are pilot drill sleeves with the following diameters: 1.5mm, 1.6mm, 2.0mm, 2.2mm, 2.35mm, 2.5mm, 2.8mm.



Template for full navigation

Full computer navigation requires the use of dedicated surgical tool sets offered by the manufacturer of the implant system.

Template for Straumann Guided system with metal sleeves, type T-Sleeve with a diameter of 5mm, designed in the program coDiagnostiX™ (Dental Wings)



Guides

Support

Depending on how the template is supported, we can classify it as:

- Teeth supported guide
- Mucosa supported guide
- Bone-supported guides directly and indirectly
- Guides with mixed support

The method of supporting the template may affect the accuracy of the procedure. The lack of precise embedding of the template in the oral cavity or the lack of stability of the template during drilling has a direct impact on the precision of the performed surgical procedure. It is widely believed to be the most precise, templates based directly on the bone or templates based on teeth.

Stabilization

Stability of the template in its place can be improved with different solutions. Additional retention is recommended in the case of the edentulous patients and with extensive deficiencies and weak residual teeth.

Several methods and instruments can be used to stabilize the templates:

- Stabilization with screws fixing the template to the bone
- Stabilization with pins set in the drilled holes in the alveolar ridge
- Stabilization with pins placed in the axis of the implant bed preparation
- Temporary implants

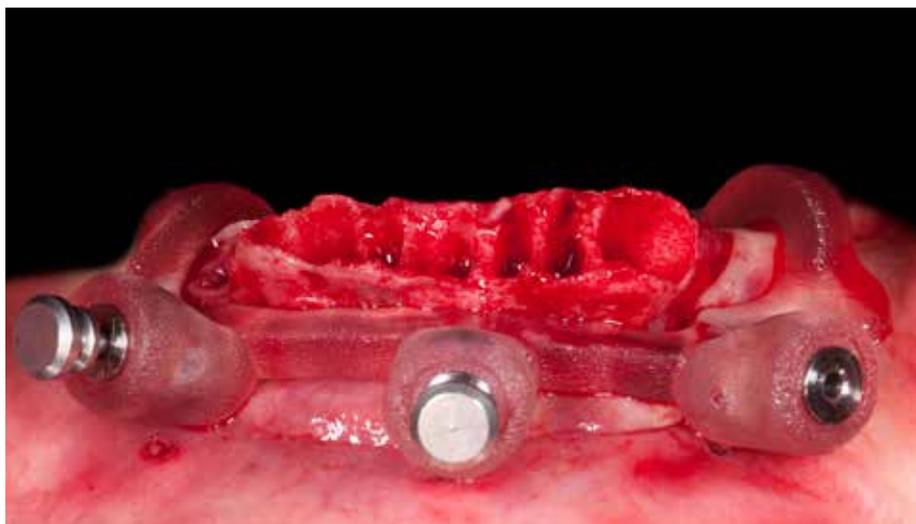
Teeth supported guide.



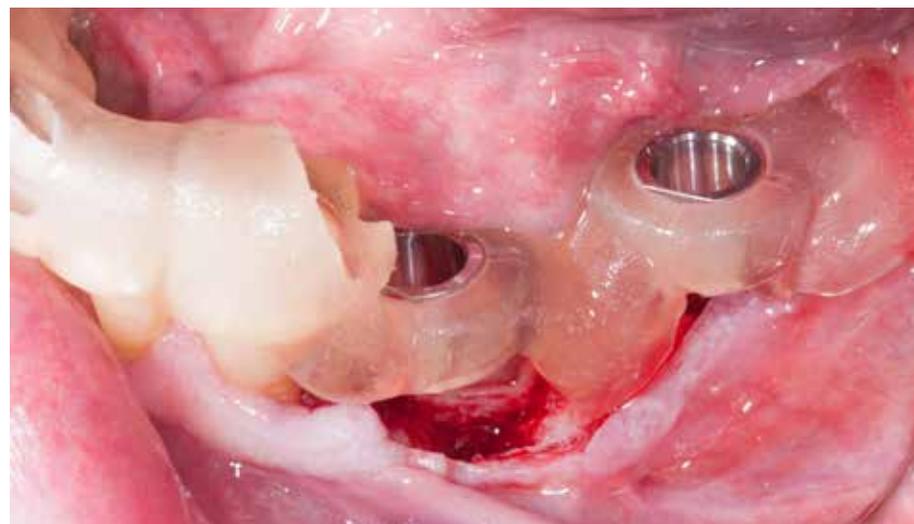
Mucosa supported guide.



Pin supported guide.



Guide with mixed support - teeth and bone support



Precision, fixing and support

What does literature say?

Zhou W, Liu Z, Song L, Kuo CL, Shafer DM. *Clinical Factors Affecting the Accuracy of Guided Implant Surgery-A Systematic Review and Meta-analysis*. J Evid Based Dent Pract. 2018 Mar;18(1):28-40. doi: 10.1016/j.jebdp.2017.07.007. Epub 2017 Jul 22.

Abstract

OBJECTIVES:

To systematically review the current dental literature regarding clinical accuracy of guided implant surgery and to analyze the involved clinical factors.

MATERIAL AND METHODS:

PubMed and Cochrane Central Register of Controlled Trials were searched. Meta-analysis and meta-regression analysis were performed. Clinical studies with the following outcome measurements were included: (1) angle deviation, (2) deviation at the entry point, and (3) deviation at the apex. The involved clinical factors were further evaluated.

RESULTS:

Fourteen clinical studies from 1951 articles initially identified met the inclusion criteria. Meta-regression analysis revealed a mean deviation at the entry point of 1.25 mm (95% confidence interval [CI]: 1.22-1.29), 1.57 mm (95% CI: 1.53-1.62) at the apex, and 4.1° in angle (95% CI: 3.97-4.23). A statistically significant difference ($P < .001$) was observed in angular deviations between the maxilla and mandible. Partially guided surgery showed a statistically significant greater deviation in angle ($P < .001$), at the entry point ($P < .001$), and at the apex ($P < .001$) compared with totally guided surgery. The outcome of guided surgery with flapless approach indicated significantly more accuracy in angle ($P < .001$), at the entry point ($P < .001$), and at apex ($P < .001$). Significant differences were observed in angular deviation based on the use of fixation screw ($P < .001$).

CONCLUSIONS:

The position of guide, guide fixation, type of guide, and flap approach could influence the accuracy of computer-aided implant surgery. A totally guided system using fixation screws with a flapless protocol demonstrated the greatest accuracy. Future clinical research should use a standardized measurement technique for improved accuracy.

Fixing the template with screws

For this type of template fixation, the dedicated screws with diameters 1.3, 1.5mm or 1.8mm are used. It is usually necessary to make pilot holes in the bone. The drilling axis and depth should be planned and determined by the sleeves that are guides for the drill.

Some systems for the template fixation offer self-tapping screws.

IMPORTANT: the placement of the screws should take into account the position of the teeth and implants and the inclination of the screws relative to the long axis of the teeth to avoid collisions during drilling and allow easy access for the operator taking into account the depth of the oral vestibule.

Fixing the template with the pins

As with the use of screws, it is necessary to drill pilot holes. The drilling axis and depth should be planned in the implant planning software and depends on the length and diameter of the pins.

The recommended pins for stabilization of templates with dedicated sleeves are offered by Straumann, Neodent and Nobel Biocare.

Fixing with the pins makes it easier to remove and reinstall the guide during the procedure without the risk of resizing of the holes in the bone with a threaded screw. However, it is essential to correctly plan the position for the pin within the existing cortical bone.

Stabilization of the template with additional titanium pins

This type of template stabilization is performed using dedicated titanium thick pins. They are inserted in the axis of the osteotomy for the future implant, and in the situation when more implants will be placed. The diameter of such an instrument matches the diameter of the sleeve in the template and the diameter of the hole made in the bone. Usually, they are color-coded.

Tip: It is best to fix the template first with pins or screws and to prepare the osteotomy in the most distal positions. Then place the thick fixation pin in the holes for rigid stabilization.



Guides

Technology and Materials

Technology

Type of technology being used depends on many factors. Templates for guided surgery can be milled out of a block of special material in a milling unit or printed on 3D printers with dedicated resins.

- **Milled templates** - are characterized by very high precision and are the most accurate. The downside is the high cost of their implementation, limiting the height of the template resulting from the thickness of the material (disc) and the difficulty of their application in the case of complex construction. Due to the nature of the production process, it is necessary to use different offset parameter settings (tolerance - clearance). Too tight parameters will prevent the template from being placed on the teeth or embedding sleeves in it.
- **Printed templates** are the most popular. This method of production is cheaper compared to milling, and there is practically no limit to the shape and size of the guide. The precision of such a template is influenced by the printing technology used, the materials used and the postproduction process. The most common are three printing technologies: DLP, SLA, and PolyJet.

Materials for printing

To make the templates, biocompatible materials must be used, with appropriate certificates allowing the use of these materials in medicine.

Supporting materials

Many 3D printers use different substances that create additional support for complex geometries of printed elements. Support materials are just as relevant to the 3D printing process as the actual basic materials. Without the support of the object during printing, there would be no successful result. After printing, the user removes the excipient from the finished part. The support material can be special wax or resins.

3D printing in a nutshell.

To create a guide printed in 3D technology, you have to go through several steps of this process:

- Creation of a virtual project (3D model) of a guide that we want to print in 3D in the dedicated software like coDiagnostiX™.
- Save the project and export it as the open STL file for the production (CAD file).
- Extract and divide the CAD file before sending it to the printer for layers.
- Sending a CAD / 3D file divided into a 3D printer.
- The printer reads each slice in a 2D file to create a three-dimensional object.



3D printing technologies

SLA and DLP

SLA printing technology

SLA (called stereolithography) is a rapid prototyping process. Those who use this technology are serious about accuracy and precision. You can create objects from 3D CAD files (computer generated) in just a few hours. It is a 3D printing process that is popular for details and accuracy. Machines using this technology produce unique models, designs, prototypes and various production parts. They do this by transforming liquid photopolymers (a special type of plastic) into solid 3D objects, one layer at a time. The plastic cures in contact with the laser beam. The printer builds each of these layers using an ultraviolet laser, directed through the X and Y scanning mirrors. Just before each print cycle, the recoater's blade travels the printed surface to ensure that each thin layer of resin spreads evenly over the printed object. The print cycle is continued in this way, building 3D objects from the bottom to the top.

Finishing - IPA washing and curing

In SLA printers, after removing the object from the printer, it is necessary to clean it in a dedicated wash with isopropyl alcohol (IPA) and curing in a special chamber for exposure (UV) and heating models (80 degrees Celsius) to ensure maximum mechanical properties of prints.

DLP printing technology

DLP (Digital Light Processing) is the oldest of 3D printing technology created by Larry Hornbeck in 1987.

The principle of operation is simple: the liquid plastic resin used by the printer goes into a transparent container with resin. DLP uses a traditional light source in the form of an ordinary arc lamp. DLP uses a digital screen to project a single image of each layer across the entire platform at once. Because the projector is a digital screen, the image of each layer consists of square pixels, resulting in a layer formed of small rectangular blocks called voxels. DLP can achieve faster printing of some parts because each layer to be printed is displayed once.

Supporting material and its removal

The elements printed in 3D technology are built layer by layer. Depending on the particular printing technology and the complexity of the model, this may mean that 3D printing requires supporting structures. Before the final treatment process, it is necessary to remove such support material. In the case of SLA and DLP technology, the support material is removed with the help of drills and/or scissors.

Time to print and finish a single surgical template

Depending on the type of technology, the time of producing a single surgical template while maintaining the highest resolution of a given device varies from a few to several hours.

Model printed in SLA technology with visible support elements.



Postprocessing

SLA and DLP

SLA and DLP

After the printing is completed, printed models must be treated with special attention to achieve desired stability, strength and final shape:

- IPA washing
- light curing
- finishing

Finishing - IPA washing and curing

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CARES® P wash

It is fully automatic cleaning station. It takes approx. 6–8 minutes | No contact with sticky resins and cleaning liquids | Touch display control | Computer-controlled programs ensure effective use of cleaning liquids



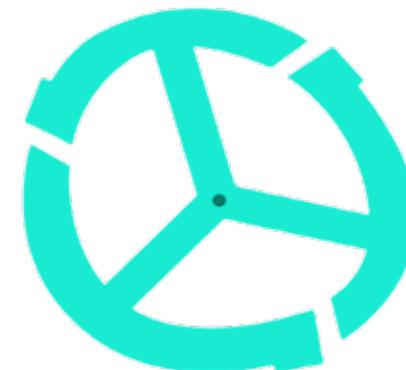
CARES® P cure

The automated curing and finishing solution to ensure maximum performance. Precise wavelength of light emission from integrated light source | Revolutionary table ensures consistent, even curing | Protective gas supply not required



Validated workflows

For Crown & Bridge models with implant analogs and stumps



P series validated manufacturing of models. One time print, 100% fit stump.

- The Minimal tolerance of stumps and work model
- Constant elasticity in small and larger stumps
- Excellent handling and haptic
- Repeatable fit by guides
- Maximum shaft length
- Minimal tolerance in XY by elastic wings
- Exact z-position by height reference
- Easy cleaning by opening for ultrasonic cleaning
- Easy printing by integrated base grid

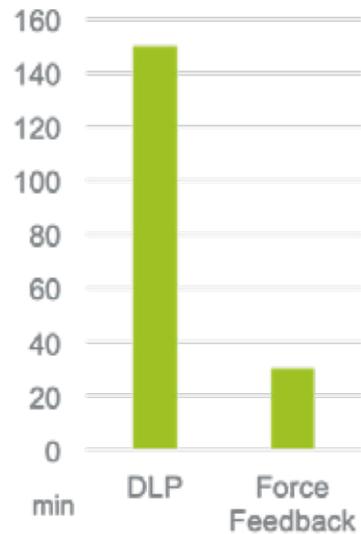


Stumps printed in different colors with Shera resins. Stumps design patented by Rapid Shape is available in the model builder of Straumann CARES and DWOS (Dental Wings).

Models printed with Shera resins with P30 printer.



A new generation of precision 3D printers from CARES®: P20 and P30. They are designed for fast and professional production of top-quality dental products. P30 Printer is designed with automatic temperature control for continuous use without dimensional changes of the final products. Touch door opener, 10-inch color display, and patented Force Feedback System come standard in each unit for a maximized production speed.



Main Features:

- Fully integrated in the validated workflow of CARES® and CoDiagnostiX™.
- Highly esthetic prints with pure color/pure transparency based on professional 385 nm UV LED
- Precise non-stop operation based on direct resin temperature regulation
- Ease of use thanks to resin handling system (RSH), automatic door and control features
- Certified auto calibration system (ACCS)
- Fast print speed makes short lab response possible by force-feedback (patented)
- Design suitable for dental labs & clinics with flat, easy-to-clean surfaces and controls



Sleeve calibration matrix

For the perfect fit

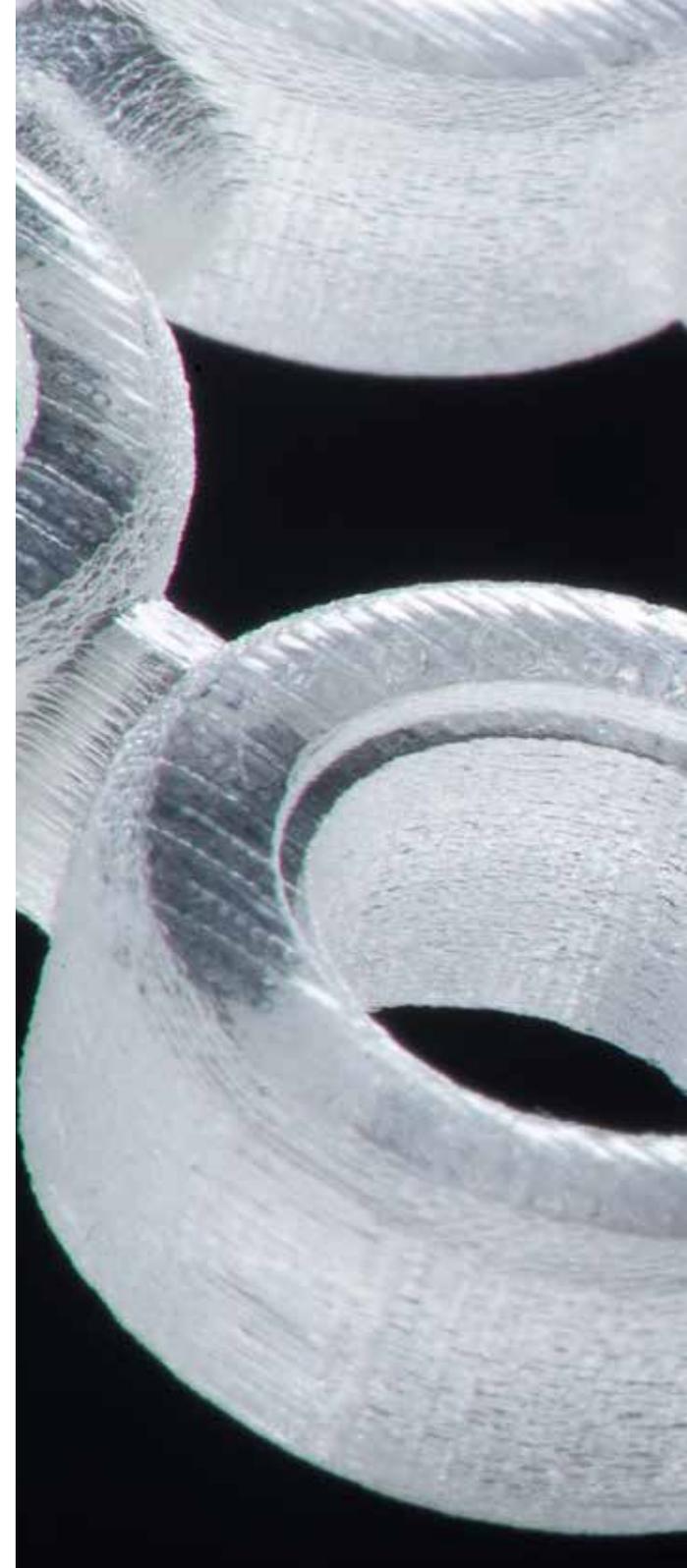
Sleeve offset calibration matrix

coDiagnostiX can output a sleeve calibration matrix. It allows the user to verify the sleeve diameter offset for the sleeve models which are used in the digital drill guide. Such verification is necessary as the fit of the sleeve depends on the material, the sleeve and the printing device actually used for production, as well as on individual preferences.

A sleeve calibration matrix allows for fine adjustment of sleeve offset values. It is usually used prior to drill guide production to make allowances for specifics of the material and printing device actually used for production. If required, you may generate and output a calibration matrix for a sleeve, even if the drill guide has not yet been designed.

Calibration matrix and printer model

The precision of fitting the sleeve in the template depends on many factors. One of them is the type of printer and technology. Even if you are dealing with another model of the same printer type, you should print the calibration matrix for each sleeve system that you plan. This approach allows you to adjust the appropriate offset for the prepared sleeve, taking into account the specific parameters of the printer.





Applications

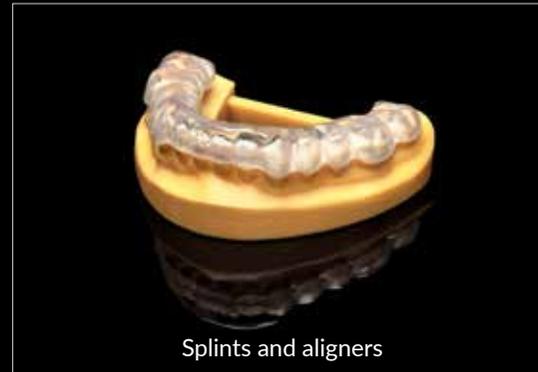
3D printers in DLP technology offer a large variety in the possibility of using different materials. In dentistry, resins are used that contain appropriate biocompatibility certificates and are often classified as Class I or IIa medical products.

Printers and resins manufacturers cross-validate printing processes using photopolymers to get the best results.

The range of applications continues to grow and is expanded every year by new types of resins in terms of mechanical properties but also of available colors.

The most common applications:

- production of all kinds of models including master models
- bite splints
- orthodontic aligners
- transfer keys in orthodontic treatment
- surgical guides
- impression trays
- soft tissue masks
- temporary crowns & bridges
- production of different types of casting objects
- highly precise production of dentures or other delicate work



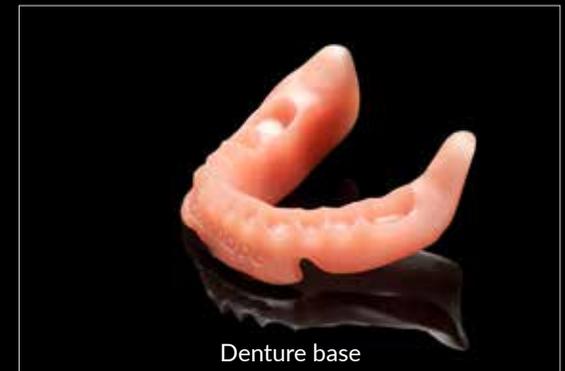
Splints and aligners



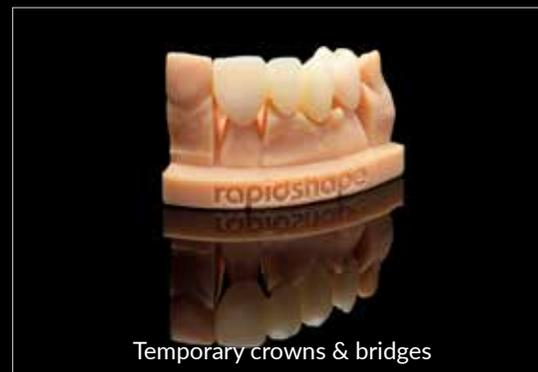
Drill guides



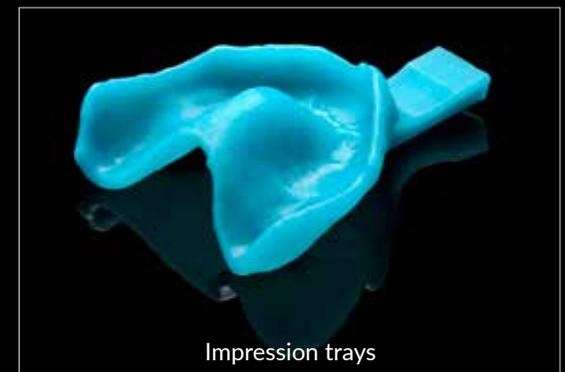
Models



Denture base



Temporary crowns & bridges



Impression trays



Multi Jet Printing and PolyJet™ printing technologies

In MJP (Multi Jet Printing) technology, the photopolymer is sprayed with thin layers and UV-cured. Multi Jet and PolyJet are technologies that use various materials during the printing process at the same time. The building material for the printed model and support material (wax or special gel) are injected from many small nozzles in a large industrial print head to create the desired part.

These technologies are among the most accurate and precise in a professional line of 3D printers.

The final finishing of printed parts is a necessary step for all types of 3D printing. After the printing process is completed, the supporting structure from the printed element needs to be removed. The difference between the MultiJet and Poly Jet models is minimal, except for one thing - removal of support material.

The Material Jetting (MJ) technology, to which the two above belong, is an additive process that works in a similar way to 2D printers. When injecting material, a printhead (similar to the printheads used for standard inkjet printing) dispenses droplets of a photosensitive material that cures under ultraviolet (UV) light to form a layer-by-layer print. Materials used in injection technology are thermoplastic photopolymers (acrylics) that exist in liquid form.

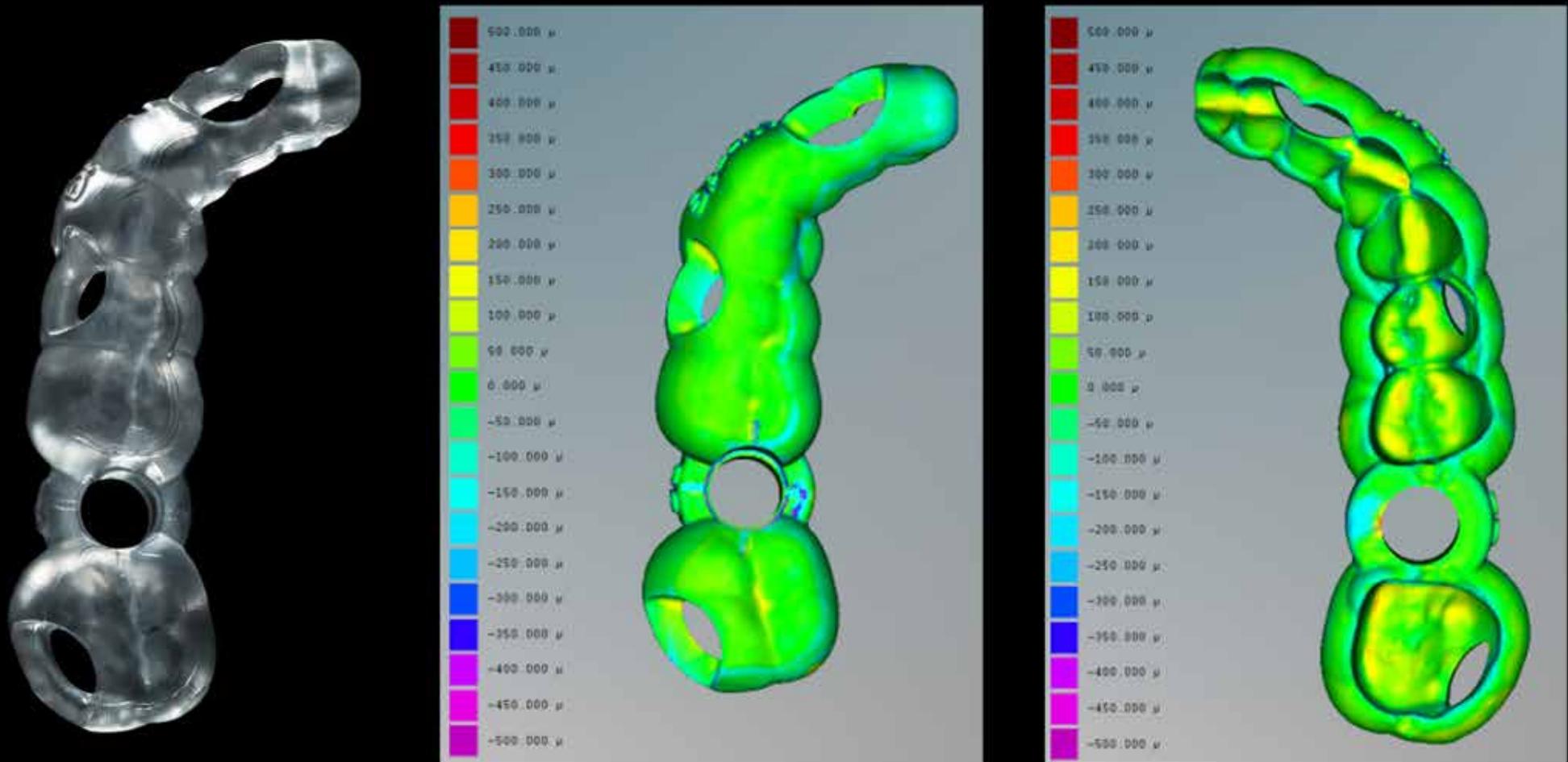
Removing supporting material in PolyJet technology.

The support structure in this technology is a mixture of propylene, polyethylene, acrylic monomer, and glycerol. After removing the printout from the printer tray, the parts are cleaned at for pressurized water in a Water Jet cleaning station. During this step, be careful not to destroy any part that has small parts or details. Water under high pressure can easily break a delicate piece. After removing the support material, the element is immersed in a chemical bath to remove residual support. After bathing, the element is rinsed again in water and the part is ready for use. This is a fairly quick process.

Removal of supporting material in Multi Jet Printing technology

The supporting structure used is a paraffin wax. After removing parts from the printer, the elements are put into a special oven to melt the wax substrate. This step may take over an hour, but there is no work or supervision in it; support is removed spontaneously. After removing from the oven, the excess of molten wax can be wiped off. With precision elements with a lot of small details, the process requires additional cleaning. An ultrasonic oil bath is used next to remove wax from the gaps. This step is also not supervised. After the oil bath, the template needs final cleaning using the dedicated detergent to remove residual oil.





Precision of the production of surgical templates

The precision of the production of surgical templates in printing technology is influenced by STL export settings, printer type, resolution, and finishing after the printing process. The leading 3D Planning and Printing Centers has undergone the process of validating the quality and precision of prints. The validation process consists in comparing the deviations of the shape of the printed template in relation to the standard, which is the STL file.

Stratasys
Objet 260/500 Dental Selection

Application
Templates, models, orthodontics



PolyJet™

3D printing technology

PolyJet is a powerful 3D printing technology that provides smooth surfaces, the accuracy of matching computer navigation templates, orthodontic models and aligners, and models for work on implants together with a printed elastic gum mask. Thanks to microscopic layer resolution and accuracy of up to 16 microns, thin wall elements, and complex geometry can be produced using the widest range of materials available in any technology.

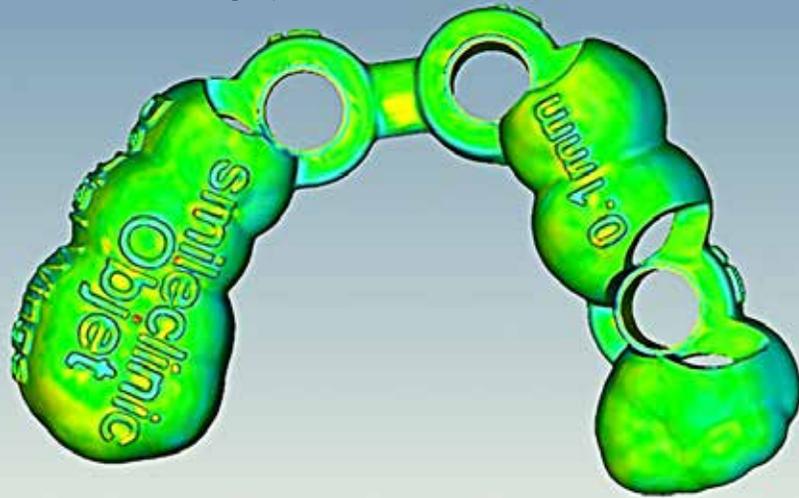
The PolyJet 3D printer prints a stream of curable, liquid photopolymer onto a built-in tray, creating unique details, smooth surfaces, and precision. Objet260 and Objet500 Dental Selection™ from the Stratasys are the only 3D printers for dental applications operating in triple injection technology, i.e., PolyJet™ 3D Printing, the most advanced technology.

A close-up photograph of a grey, curved component of a 3D printer. The word "stratasys" is printed in a light grey, lowercase sans-serif font on the surface.

stratasys



Objet260
Dental Selection™



In order to guarantee the quality of the print offered by the reference laboratories, Dental Wings conducts the so-called validation. It consists in checking the level of distortion of the printed template in comparison to the pattern. Template view that meets the rigorous validation requirements.



Implant model printed in PolyJet™ technology.



Stratasys® offers an impressive range of dental materials for one of the most innovative 3D printing technologies, PolyJet™. Combining the highest accuracy, high precision and dimensional stability, 3D printers of the Stratasys Dental series use these materials to create computer navigation templates, orthodontic brackets, prosthetic restorations and models with high precision and accuracy.

- Realistic colors, texture, and details: a 3D printer that allows you to create a rigid model base and a soft gum mask in the realistic shades of teeth and gums.
- Orthodontic models and aligners
- Templates for computer navigation



Implant model printed in PolyJet™ technology

The model consists of a base printed in ivory-colored material with embedded implant analogs and a flexible, removable gum mask. Through the possibility of mixing materials in the printing process, it is possible to change the elasticity of the gum mask from very soft to hard.

Disinfection & sterilization of guides

Important information

Surgical templates must be subjected to a cleaning, disinfection or sterilization process after the manufacturing process. Depending on the technology of their production and the materials used, there may be significant differences and recommendations for their preparation before surgery. Particular attention should be paid to the manufacturer's recommendations regarding the possibility of chemical and thermal treatment.

Disinfection of surgical templates

A common form of disinfection of surgical templates prior to their use is the use of chlorhexidine (**chlorhexidine gluconate**) bath solution. However, as research shows, **this is not the most effective method.** (Smith PN1, Palenik CJ, Blanchard SB., Int J Oral Maxillofac Implants. 2011 Mar-Apr;26(2):274-81. Microbial contamination and the sterilization/disinfection of surgical guides used in the placement of endosteal implants.)

The mechanism of action of chlorhexidine is based on the affinity for negative ions of the cell membrane, which allows it to penetrate the bacterial cell, where it precipitates the cytoplasm, leading to the formation of insoluble antigen-antibody complexes. The effect of this reaction is to inhibit the growth or destruction of the bacterial cell.

(Paniczko A., Waszkieł D.: Chlorheksydyna i PerioChip w leczeniu chorób przyzębia. Magazyn Stomal., 2003, XIII, 12, 31-32.)

Low-temperature sterilization of surgical templates

Before sterilizing the templates, check the manufacturer's recommendation. The vast majority do not recommend sterilization in an autoclave due to the risk of deformation of the templates.

Stratasys recommends low-temperature sterilization, such as:

- Plasma sterilization with hydrogen peroxide

The high energy particle used to create the plasma is a destructive factor for living matter. This leads to the elimination of electrons from some atoms, which leads to the acceleration of free electrons, atomic nuclei, and entire atoms. In the so-called "Cold" sterilization introduced into medical practice recently, hydrogen peroxide is used as the source of the plasma. Under the influence of electromagnetic radiation with high energy, in the conditions of high vacuum hydrogen peroxide radicals are formed which show a destructive effect in relation to microorganisms. After running out of energy from these radicals, water and oxygen particles are formed, which are no longer a threat. The sterilization cycle takes 45-105 minutes and runs at 40°C.

- Ethylene oxide (EtO) sterilization

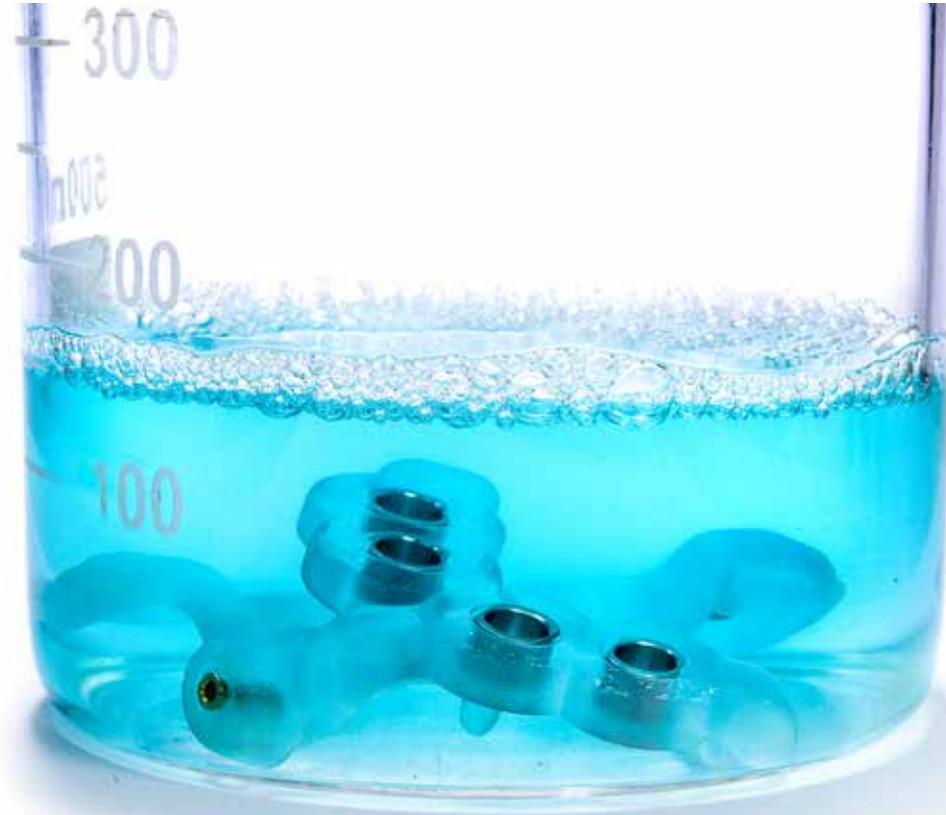
Ethylene oxide is a strongly bactericidal (also affects spores) and virucidal, having the ability to penetrate and penetrate deep into the material. It already has its activity at 400-1000 mg, 30-60% relative humidity and 50-60 ° C. Pure ethylene oxide or its mixture with carbon dioxide (1: 9) are used for sterilization, and the process itself is carried out in a gas-tight chamber. Ethylene oxide is used to sterilize materials and medical equipment made of plastics that could deform under the influence of temperature.

Sterilization of surgical templates in autoclave

Sterilization of templates in an autoclave creates a risk of deformation. In response to the demand of the medical market, some companies have started to introduce 3D printing materials that meet stringent requirements regarding the process of autoclaving. An example of such a material is **SHERAprint-ortho plus UV** Light-curing 3D printing resin certified as medical device class IIa.

- SHERAprint-ortho plus UV is validated for the „W&H Lisa 522, Program UNIVERSAL 121“ sterilisation process.

Surgical guides should be submerged in 70% alcohol for a minimum of 15 minutes or undergo sterilization using ethylene oxide gas.



* Smith PN1, Palenik CJ, Blanchard SB., Int J Oral Maxillofac Implants. 2011 Mar-Apr;26(2):274-81. **Microbial contamination and the sterilization/disinfection of surgical guides used in the placement of endosteal implants.**

*Water, chlorhexidine gluconate, and diluted bleach were not totally successful in decontaminating the surgical guides, but no growth was found after 15 minutes of immersion in 70% ethanol. Preferably, surgical guides should be submerged in 70% alcohol for a minimum of 15 minutes or undergo sterilization using ethylene oxide gas.

Disinfection & sterilization of guides

Literature

Smith PN1, Palenik CJ, Blanchard SB., Int J Oral Maxillofac Implants. 2011 Mar-Apr;26(2):274-81.

Microbial contamination and the sterilization/disinfection of surgical guides used in the placement of endosteal implants.

PURPOSE:

The purpose of this study was twofold: (1) to estimate the level of microbial contamination found on commercial guides (CG) and in-house laboratory guides (LG) prior to use, and (2) to evaluate the antimicrobial potential of disinfectants commonly used in dentistry to decontaminate heat-sensitive surgical guides. Ethylene oxide gas was used as the positive control; sterile water served as a negative control.

MATERIALS AND METHODS:

Evaluation of CGs and LGs for bacterial contamination occurred soon after their arrival in the laboratory. Some guides went directly into tubes of trypticase soy broth solution, vortexed and equally divided into two tubes. One tube went into an 80°C bath for 19 minutes, while the other stayed at room temperature. After plating, half of the samples underwent anaerobic incubation. All incubation was for 48 hours at 37°C. Other guides underwent water rinsing or disinfection by various methods for 5 or 15 minutes or ethylene oxide gas sterilization prior to sampling.

RESULTS:

Untreated CG specimens showed modest levels of bacterial contamination, with most colonies coming from liquid specimens not exposed to 80°C. LG specimens had more bacteria from both heat-treated and non-heat-treated aliquots. Chlorhexidine gluconate, diluted bleach, and water rinsing were not able to completely eliminate microorganisms on the specimens, but no viable microorganisms were present on specimens treated with gas sterilization or 70% ethanol for 15 minutes.

CONCLUSION:

CGs and LGs, on average, had different levels of bacterial contamination prior to disinfection. Water, chlorhexidine gluconate, and diluted bleach were not totally successful in decontaminating the surgical guides, but no growth was found after 15 minutes of immersion in 70% ethanol. **Preferably, surgical guides should be submerged in 70% alcohol for a minimum of 15 minutes or undergo sterilization using ethylene oxide gas.**

Checklist

Before starting the procedure, always check a few elements:

The cleanliness of the template

Check if the template is clean and there are no residues of the support material.

Case number and/or Patient ID

Check if the template is consistent with the intended use of the planned treatment.

Adaptation (fit) on the model

Check the fitting of the template on the control model. The template should not sway and have a very tight or too loose fit.

Inspection windows

Verify a close fit of the template on the teeth of the model and in the mouth.

The position of the sleeve

The metal sleeves are pressed into the template. The upper edge of the sleeve should be clearly pressed against the hole in the template.

Surgical protocol

Familiarize yourself with the document and check the order of use of the planned tools. Check if all items are ordered in accordance with the protocol.

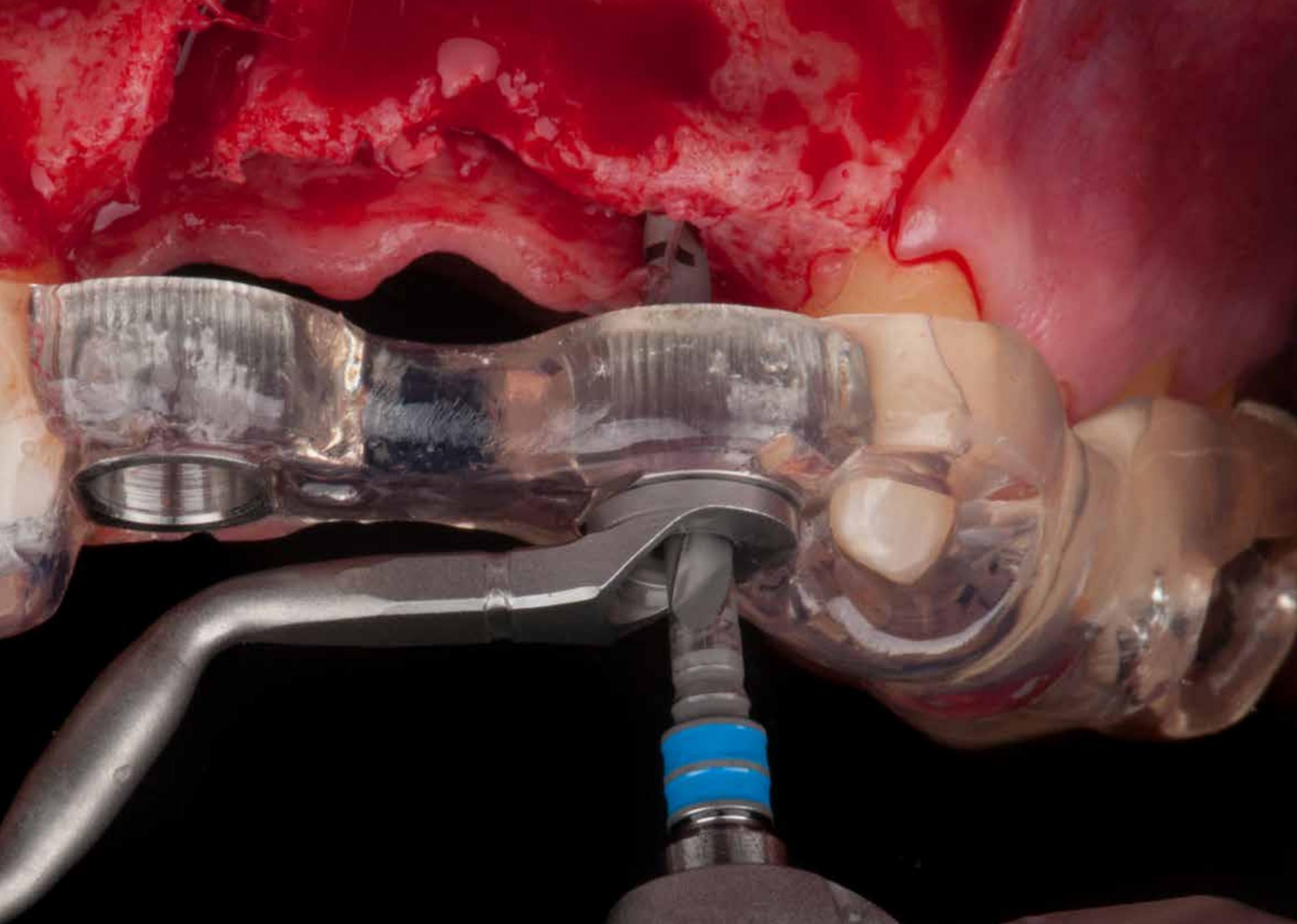
Disinfection and/or sterilization

Most materials from which templates are made cannot be sterilized in an autoclave. Follow the procedures recommended by the manufacturer of materials for a specific printer and printing technology.



Clinical Cases







Case 1

Immediate implantation

Description :

Diagnosis: *external root resorption*

Treatment: immediate implantation in position 23, non-functional immediate load, one-time abutment

Planning: coDiagnostiX™ (Dental Wings)

Tools: Guided Surgery Straumann®, Straumann® BLT SLA Roxolid® Implant

Planning, Surgery and Prosthetics

Krzysztof Chmielewski, DDS, MSc

Gdańsk / Poland

Dental technology

Björn Roland MDT

Klein-Winternheim / Germany



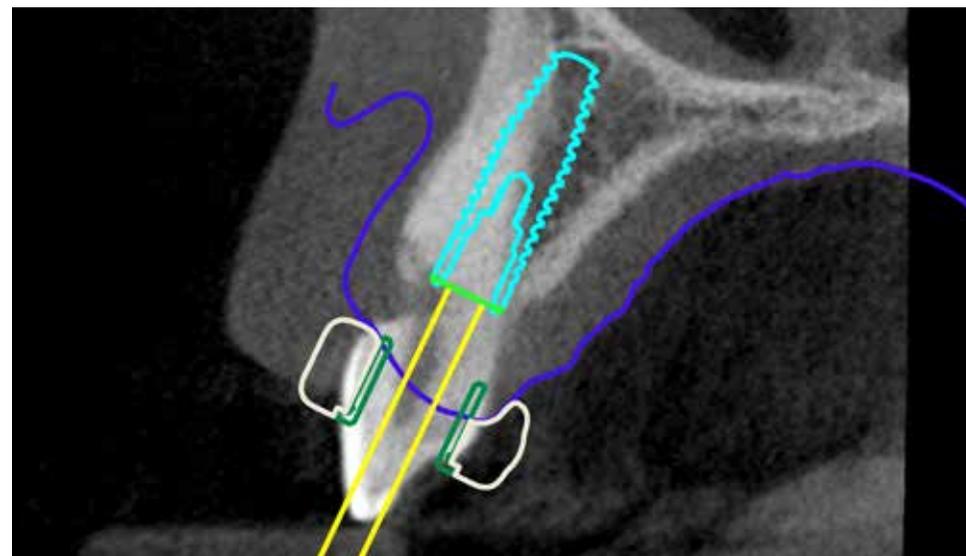
Initial situation. In the case of superficial examination, one can omit a significant problem related to external root resorption of the tooth 23.



During the follow-up examination, anxiety was caused at the edge of the zenith (23). The patient did not report any pain. View of the destruction of the root of the tooth 23 with the granulation tissue penetrating the tooth.



A significant degree of external resorption was confirmed in the CBCT examination. The resorption depth of 3 mm was measured.



Planning the implant position and template design for guided surgery were made in the software coDiagnostiX™ with respect to the immediate implantation.



Before the surgery, the laboratory delivered a template for full guided surgery and immediate implantation, a final hybrid abutment with a temporary crown and a coping for the final crown.



Hybrid abutment based on Variobase (Straumann) titanium abutment and zirconium oxide (Kuraray / Noritake). Temporary crown made of PMMA material. Coping for the final crown made of zirconium oxide.



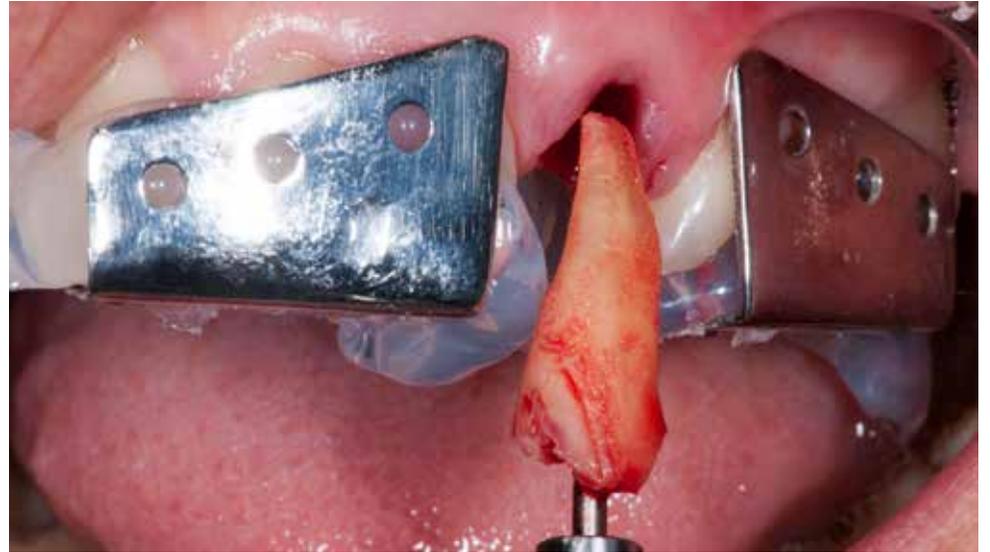
Starting situation before surgery. To perform the surgery, Ubistesin Forte anesthesia was delivered (articaine with adrenaline 1: 200,000) using the Wand device.



Removal of coronal part of tooth 23. Extensive resorption led to easy detachment of the crown from the root.



After removal of the tooth crown, the root 23 is visible in the alveolus and the granulation tissue infiltrating from the vestibular side.



Removal of the root with the Benex Extraction System (Helmut Zepf Medizintechnik GmbH / Germany).



Checking the fit of the guide immediately after tooth extraction. Pay attention to the fit of the template within the inspection windows and whether the template balancing occurs.



View of the template with support on the teeth. Two inspection windows are used to verify the position of the guide. The T-sleeve (Straumann) sleeve is mounted in the template, and the index indicator is shown in black.



Straumann Guided computer navigation requires the use of a surgical tray with drills and dedicated drill holders. The sequence of the used drills is in accordance with the surgical protocol.



The osteotomy axis and depth is checked after the preparation is finished. There is a noticeable palatal shift of the preparation tip relative to the root axis.



Insertion of the Straumann Bone Level Tapered Roxolid SLA RC implant (D4.1/L14mm) is also made through the navigation template. This is called full navigation.



Straumann Guided implant carrier, has depth markers marked with horizontal cuts (H2, H4 or H6) and dots indicating the index in the implant. The dot and mark for the index on the template (black line) should be aligned.



The implant was placed in the ideal position of the aesthetic window. The vestibular line, guided between two adjacent teeth at the height of the enamel-cement border, marks the boundary of the safety zone.



Final hybrid abutment based on Variobase (Straumann) is inserted after surgery. Make sure that the surface is polished and that there is no gap between the titanium base and the zirconia.



The shape of the abutment ensures optimal support of the soft tissue emerging profile. The bevel for the crown on the abutment is 0.5mm below the zenith of the soft tissue and should follow the shape of the profile.



The abutment is tightened with a torque of 35Ncm. If the initial fixation of the implant is less than 35Ncm, then the abutment should be screwed with a lower torque, e.g., 20-25Ncm. The entry for the screw is closed with a Teflon tape.



To control the amount of temporary cement, an abutment stamp is made. For its implementation, a micro brush tip and material for temporary crowns were used.



The cementation of the temporary crown begins with the application of temporary cement (e.g. Temp Bond / 3M Espe) to the crown and removing its excess with the previously prepared stamp.



Remove the excess of the cement. Thorough cleansing of the subgingival area determines the healing process.



Immediate non-functional load requires complete freedom of the crown in occlusion and lateral movements. Contact points should also be unloaded.



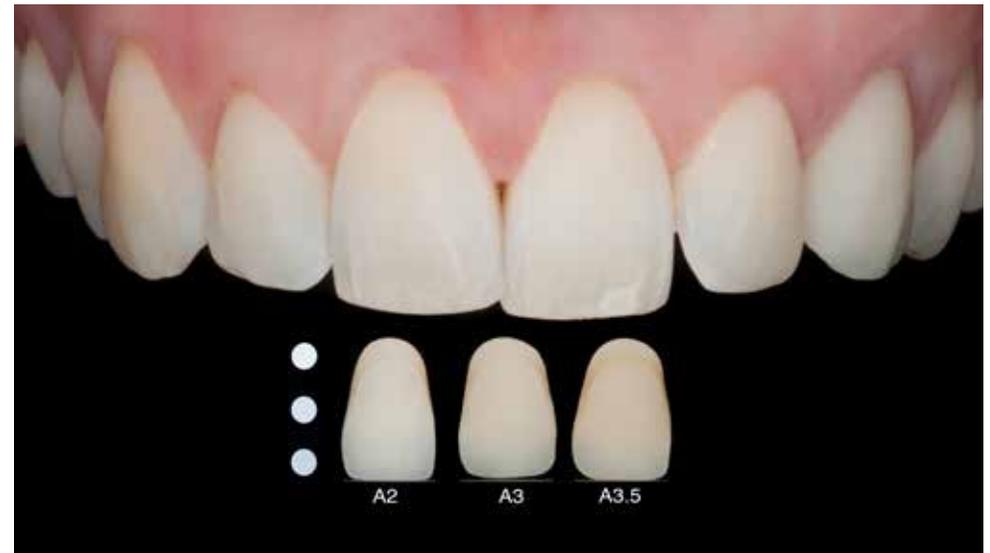
The healing process after eight days from the surgery. Lack of tissue reactions and beautiful adaptation of soft tissues around the periphery of the temporary crown and abutment in position 23.



Situation after four months from the immediate implantation. A stable soft tissues around the crown, both within the zenith of the gum and in the level of the papilla.



The shade selection. Three shade tabs A2, A3 and A3,5 from the VITAPAN® classical color palette (Vita Zahnfabrik GmbH / Germany) are visible. Photograph with dual flash at 45 degrees on the bracket.



Images in the reflected cross-polarized light help in the additional evaluation of the tooth's brightness and color saturation.



Additional information about the target color for the ceramic restoration in position 23 can be taken from the reference, which is a canine on the right side of the jaw.



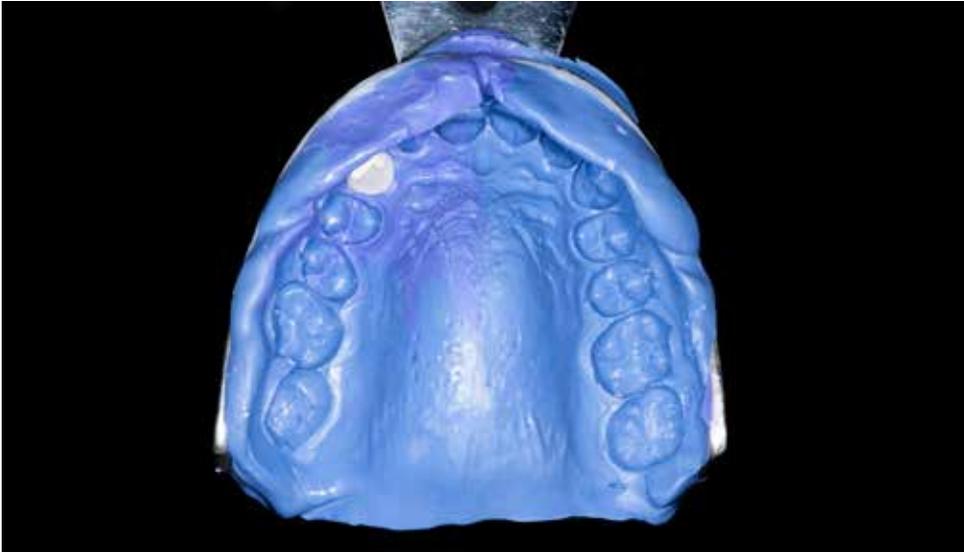
In the "one-time abutment" technique, the abutment remains unscrewed after it has been inserted during the implantation procedure.



The information about the position of the abutment is transferred using the coping that is the base of the final crown. The coping has been made and delivered before the surgery and is perfectly matched to the abutment.



Placement of the coping on the abutment and taking additional photos in polarized light for transferring the maximum information for the ceramist.



Silicone impression with the coping is transferred to the laboratory. To stabilize the coping during the impression taking, a small portion of the temporary cement was applied to the crown.



The final crown was made by firing Kuraray / Noritake ceramics on the zirconium oxide coping.



The anatomical shape and color of the crown are carefully matched to the existing dentition.



Preparation of the stamp for cementing the final crown. From the micro brush applicator, cut off the "head."



The part of the shaft will be the basis for placing the stamp on it.



Filling the crown with material for temporary restorations such as Structur or Luxatemp.



Insertion of applicator shaft for material in the liquid phase.



After chemical polymerization, it is easy to remove the stamp from the crown.



Final cementation of the crown with RelyX™ U200 cement (3M Espe).



The cement is introduced using a thin mixing tip and applicator to avoid closing air bubbles.



Excess of the cement is removed with prepared in advance stamp.



Light polymerization after final positioning of the crown on the abutment.



Removal of the polymerized material from the subgingival region using a very thin probe.



Control examination showing the position of the implant in cross-section and stable bone volume.



The end result - preserved harmony and consistency of the shape and color of the prosthetic restoration.





Case 2

Immediate implantation

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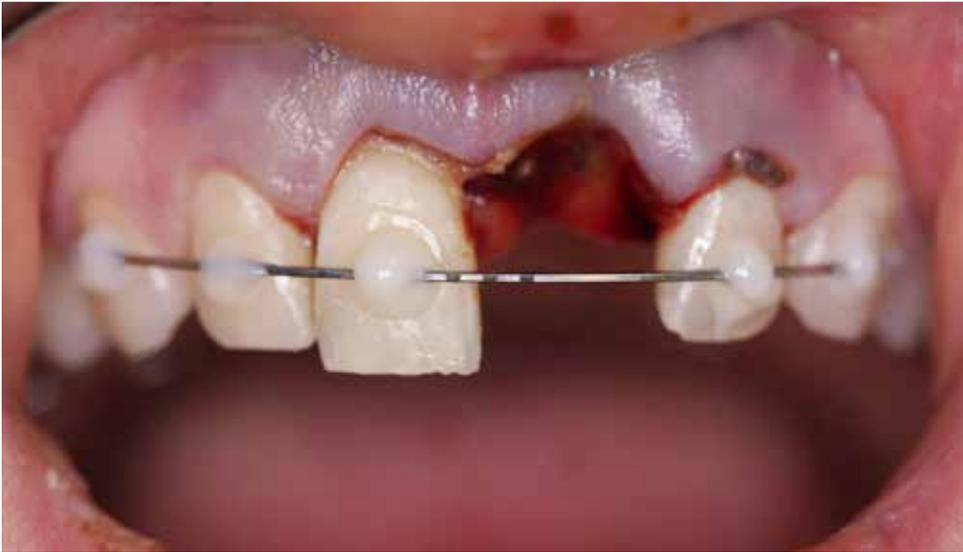
Description :

Diagnosis: *External resorption of roots and inflammatory changes following extensive trauma.*

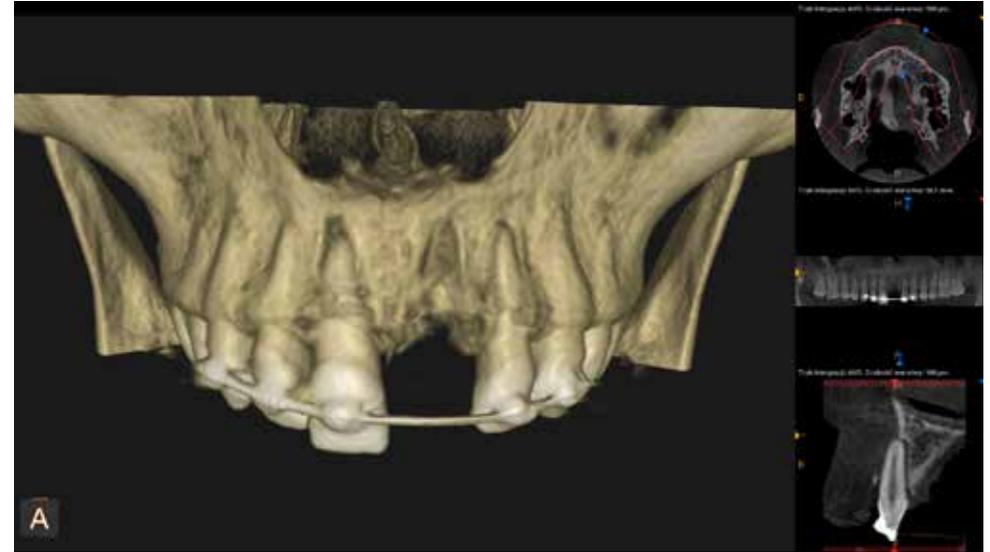
Treatment: Immediate implantation, non-functional immediate load

Planning: coDiagnostiX™ (Dental Wings)

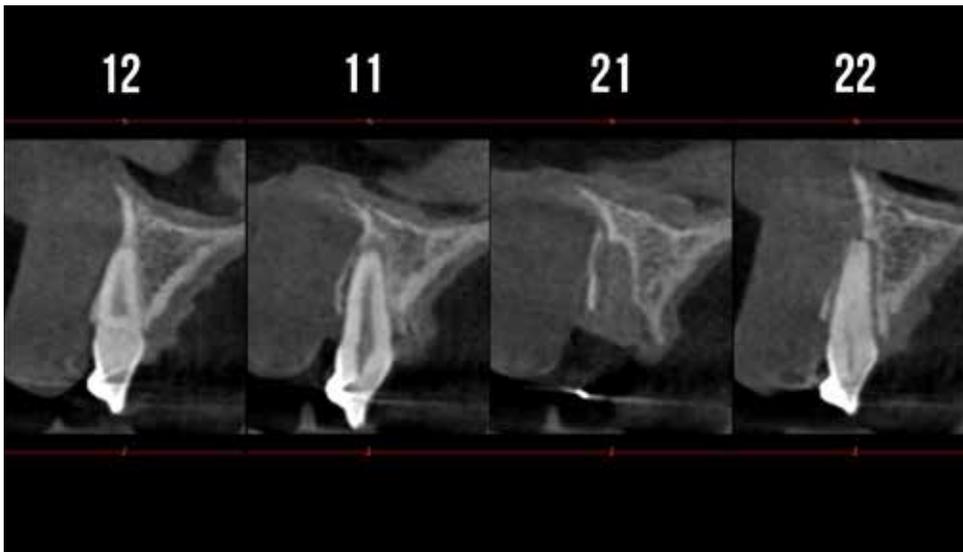
Tools and Materials: teeth supported guide for immediate implantation, Straumann Guided surgery, Straumann BLT SLActive Implant, botiss biomaterials



Following the injury, the patient lost the central incisor on the left side, and the remaining incisors were dislocated. After the injury, the teeth were splinted, and the patient was sent to our Clinic for further treatment.



3D reconstruction in the CBCT revealed a significant degree of injury to the alveoli of all upper incisors.



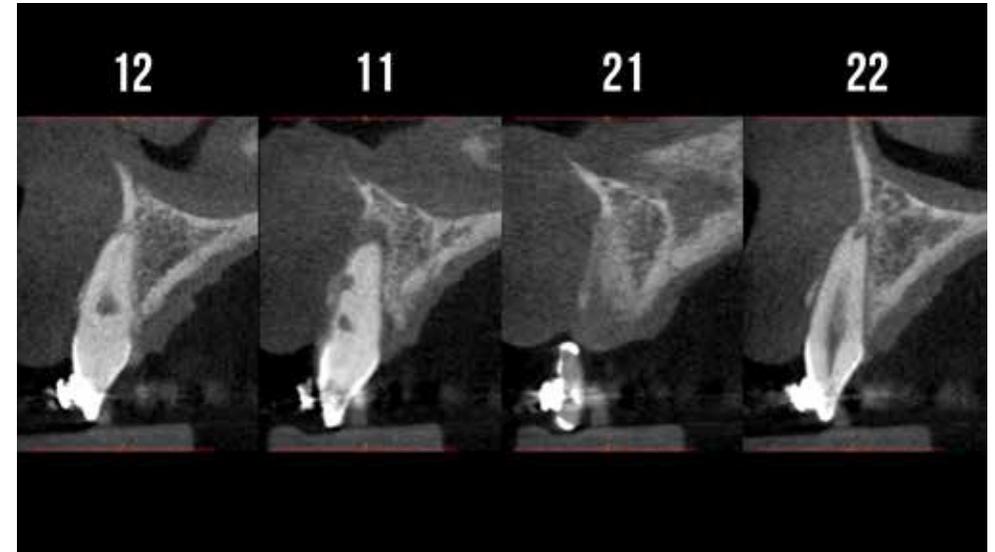
In the CBCT examination, there are visible changes within the teeth. 12 - transverse root fracture, 11 and 22-dislocation, and fractures within the alveolus.



In the first phase, an orthodontist replaced the rigid splint with a soft one and left the patient supplied in this way for three months to heal the tissues.



After three months, the patient reported an abscess located in the vestibule of the oral cavity projecting on the root of tooth 11. In the CBCT, bone and roots were remarkably damaged.



In cross-sections, visible propagation of the fracture in the tooth 12 and the progressive external resorption of the roots of teeth 11 and 22 in the apical part and the vestibular, mesial and distal walls.



After the consultation, a treatment plan was accepted. Treatment Plan: extraction of the remaining incisors and replacing them with a bridge supported with two implants placed in the position of the lateral incisors using computer navigation.



Cleaning teeth from the remains of orthodontic brackets. Visible bone necrosis within the soft tissue between central incisors.



Preparation for planning and making the template starts with the impression taking with alginate to pour the models.



Upper jaw model.



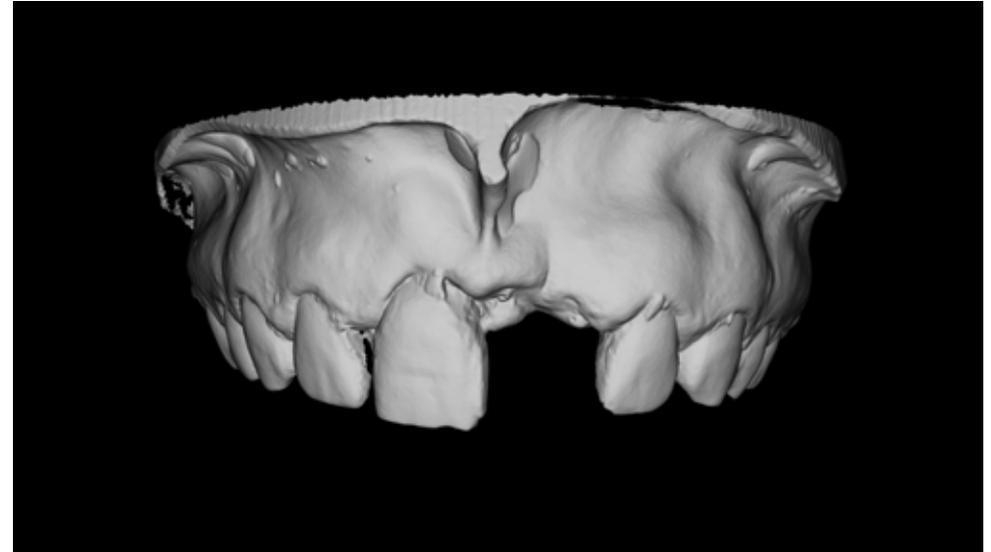
Preparation of immediate temporary restoration with a thermoplastic foil based on wax-up of the central incisor.



The thermoplastic foil was filled in the place of the missing tooth with a composite material. The patient is wearing such a temporary solution until the start of surgical treatment.



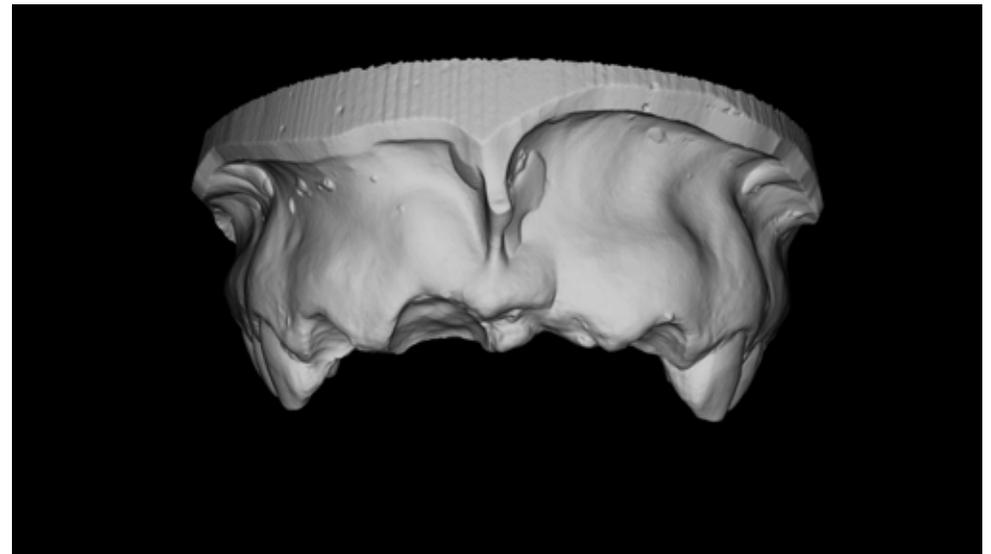
The same jaw model that was used to make the temporary foil was scanned in the laboratory to create a digital model and was saved in STL format



The digital model of the upper jaw - the beginning of treatment (STL file).



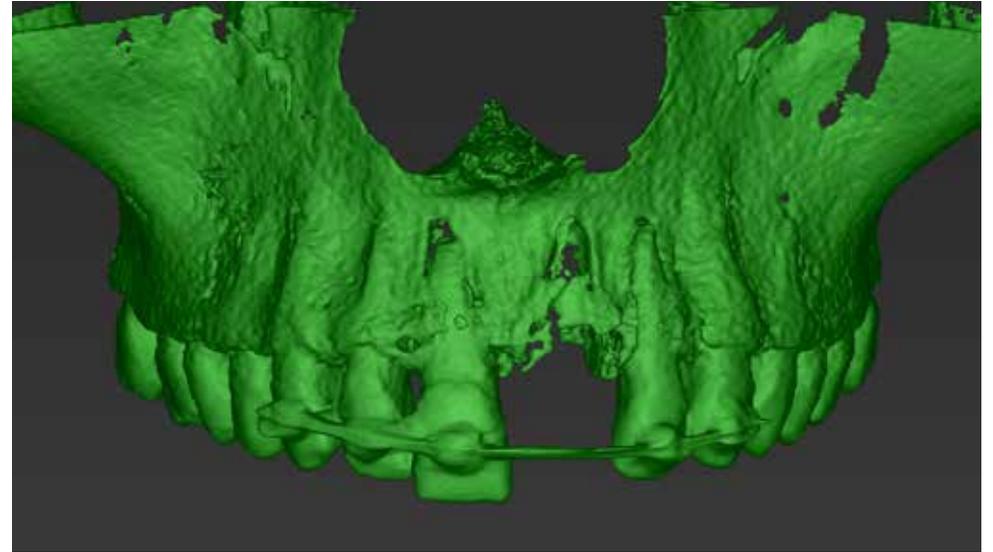
Then, the incisors planned to be extracted were cut from the model, and the model was scanned again.



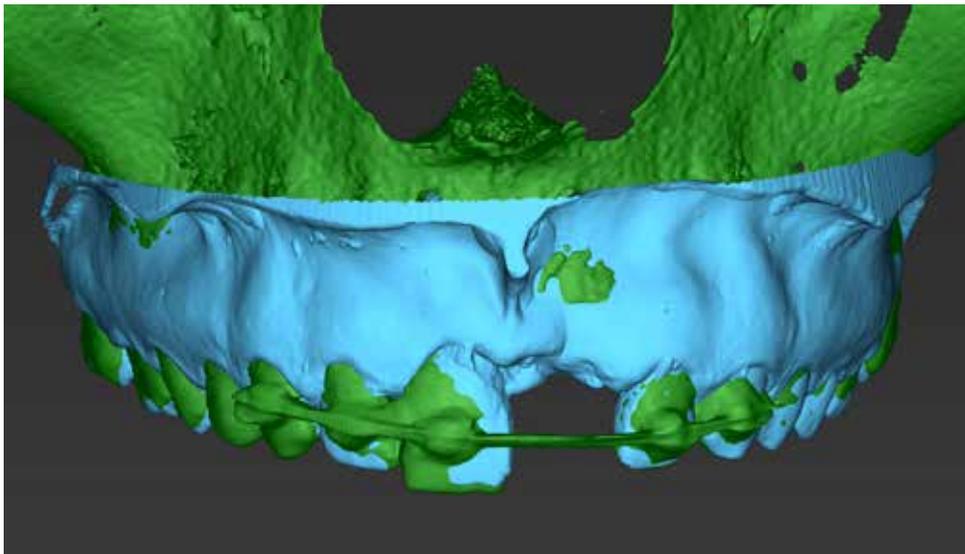
In the scanning process, a second jaw model was obtained, this time without incisors. It will be used to design a template for computer navigation.



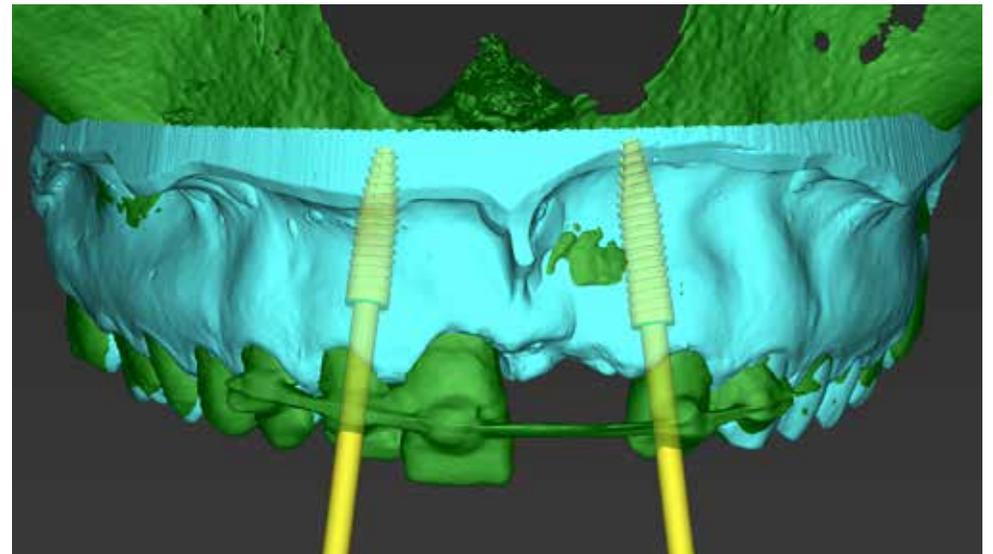
The coDiagnostiX™ (Dental Wings) software was used to plan the position of the implants and to design the template.



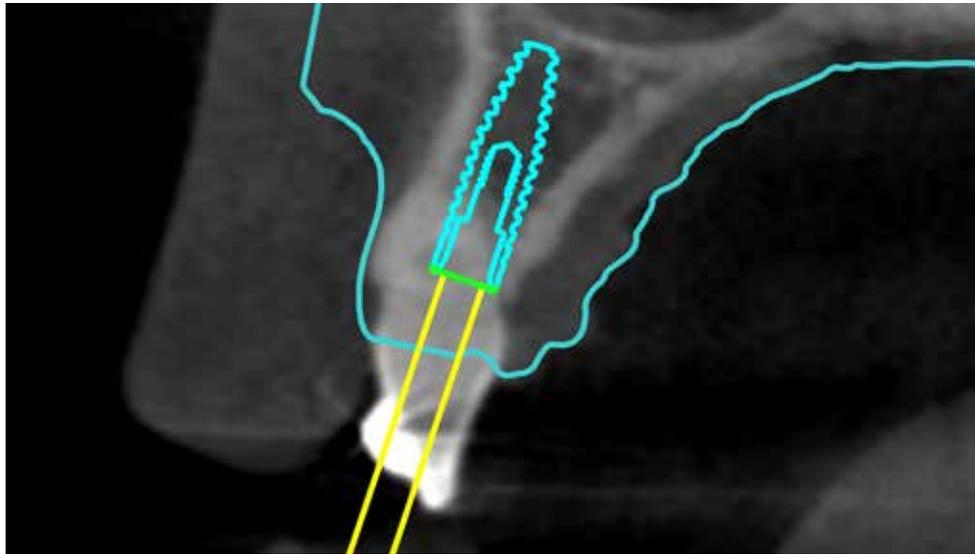
In the process of segmentation of images obtained from the CBCT examination, an image of the jaw was isolated which was stained green.



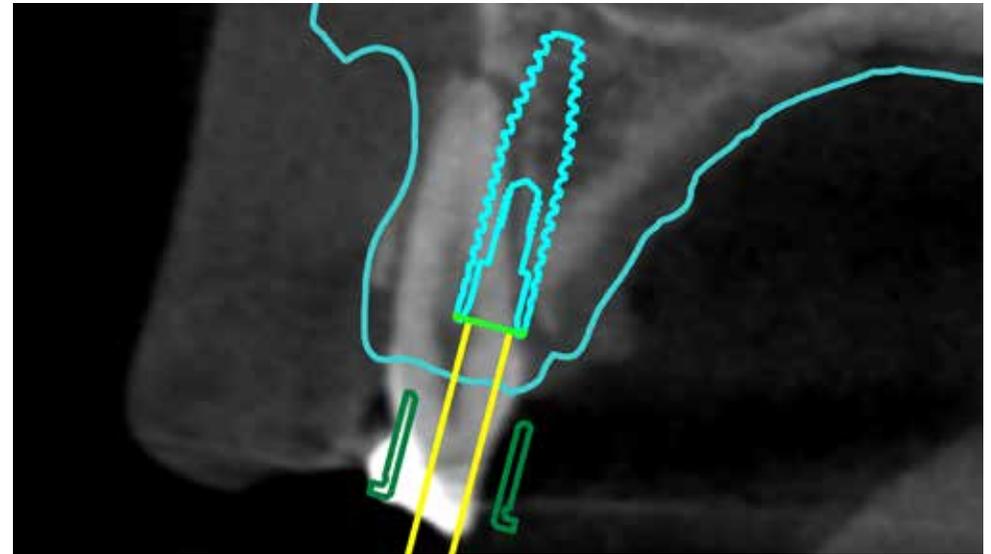
Then the images of the bone, soft tissues, and teeth were merged. Proper integration of DICOM and STL files is the basis for precise planning and template execution.



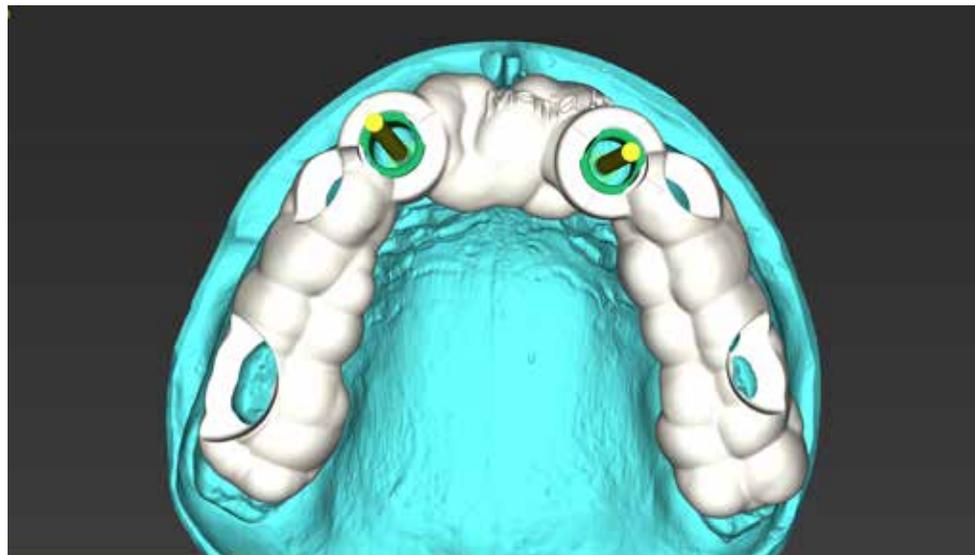
Planning the position of implants in relation to the level of hard and soft tissues helps to build final aesthetic prosthetic reconstruction.



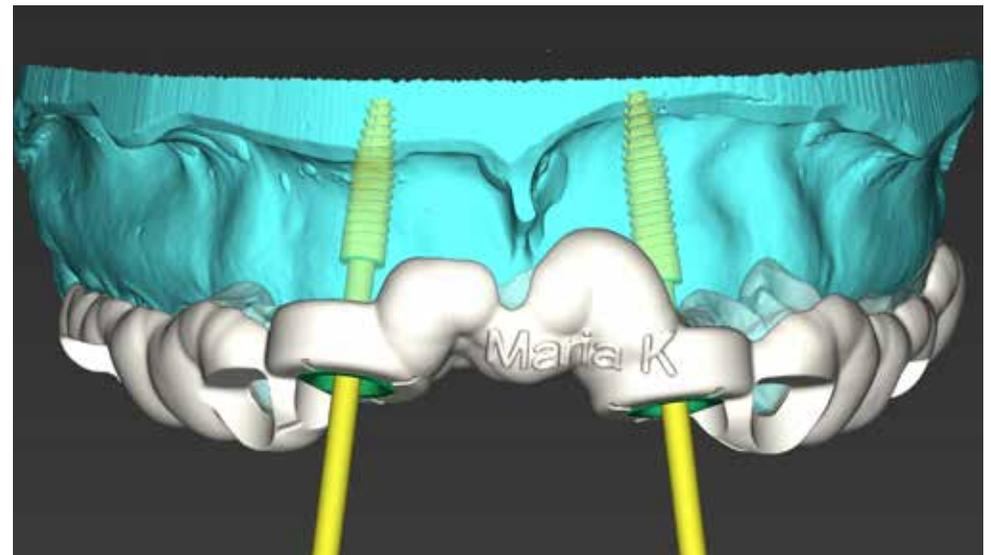
Planning the implant in the position of the tooth 12 and setting the axis to obtain retention in the bone of the alveolar ridge.



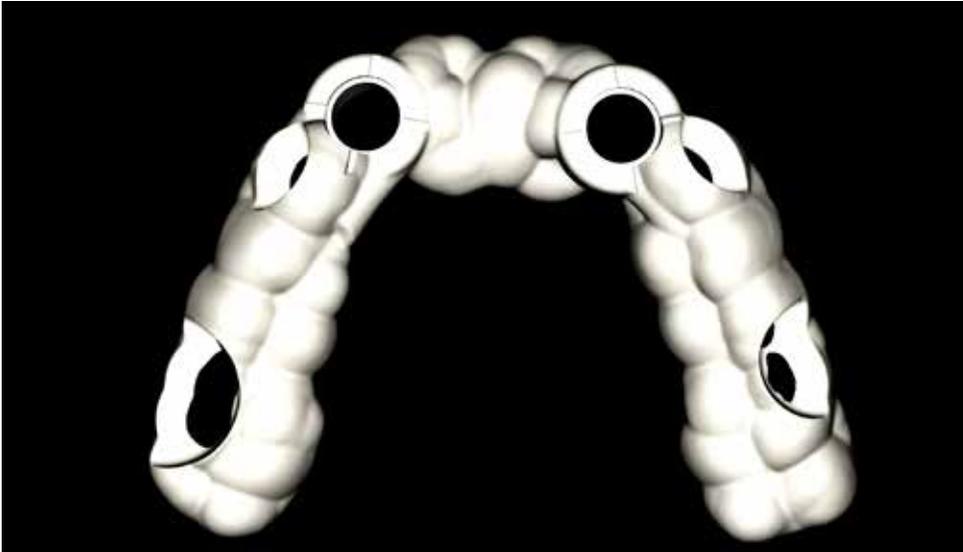
Planning the position of the implant on the left side in the maxilla. Moving the axis to the palate for better anchoring in the bone.



Template design for full navigation and immediate implantation. Four inspection windows are located in the position of molars and canines. The support on the teeth provides stability for the template.



3D view of the template design. The thickness of the wall, position of the inspection windows or the location of the support points on the teeth or mucous membrane is just some of the parameters that can be customized.



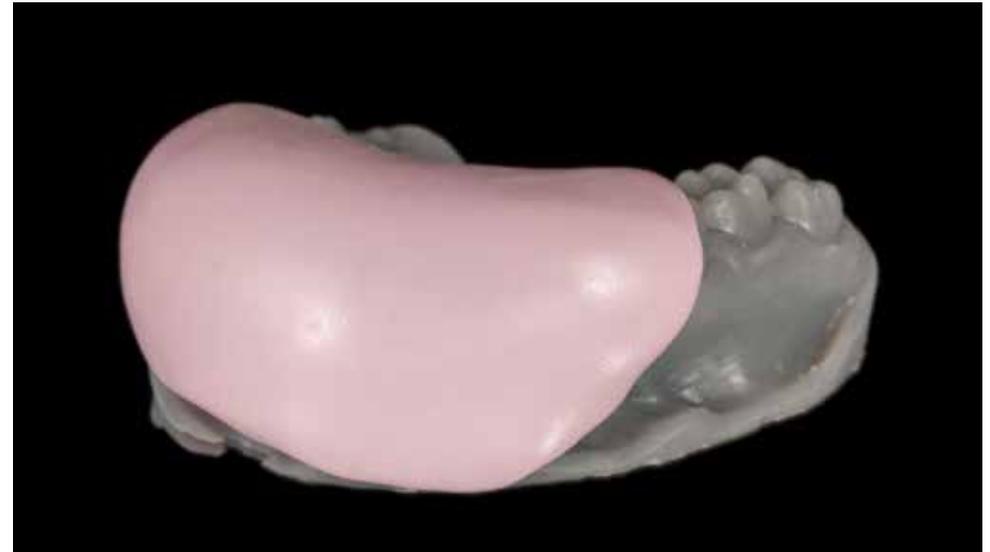
Designing process of the template ends with the export as the open STL file. This allows printing the template or milling on any printer or milling unit.



Printed template with embedded sleeves for full Straumann Guided navigation. Additionally, indicators for positioning the implant index are marked with a black marker.



From sent STL files, the dental laboratory in Germany prepared temporary restorations. The first stage was the printout of the jaw model.



Preparation of the silicone index (Merz Dental TS 5000) for the gingival mask.



The silicone index made from the printed model should accurately reflect the state and position of the soft tissues in the anterior section of the jaw.



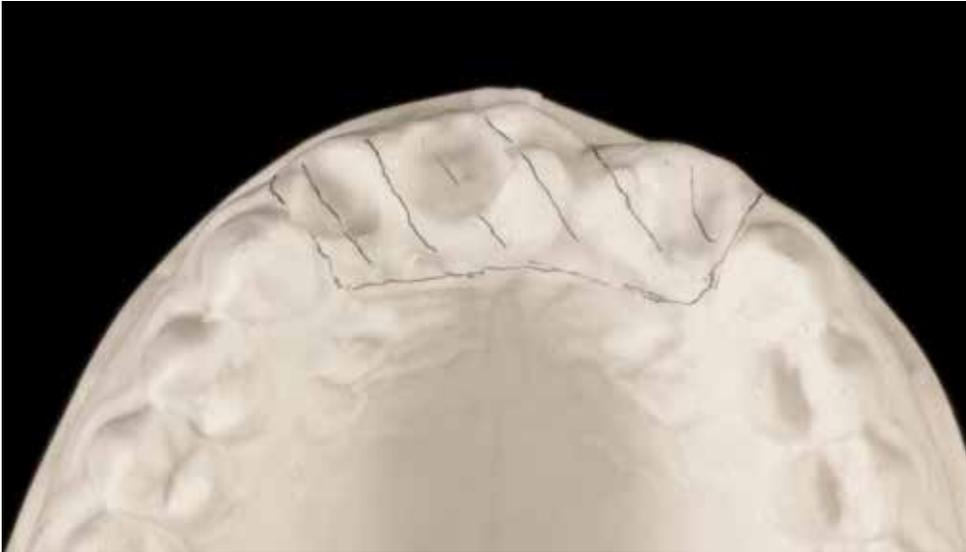
Preparing the index for further use. Cutting the index and revealing the position of the teeth for the reference of passive seating on the model.



Preparation of the form for duplication of the printed model with a silicone material (Zermack Elite Double 22 Fast).



Duplicated plaster model (Picodent QuatroRock white).



Selection of the area to be replaced by the gingival silicone mask.



Gypsum was reduced in the thickness at the place of selection by a thickness of 2-3mm.



In the position of the planned implants, the model was drilled through the full thickness through the base. The size of the holes must be made in the axis of the implants and be larger than the diameter of the implant's analog.



Implant analogs are fixed in the model using the template for navigation. Based on the information obtained in the coDiagnostiX™, the technician knows all the necessary parameters related to the implant position.



Fixing the implants from the base of the model using acrylic or light-curing resin.



Fixing the implants by filling the space between the plaster and the analogs ensures stable seating and prevents rotation.



In the silicone index, places for cutting two holes through the full thickness of the index are marked. Analogs in the model can be protected with Teflon or wax. Use a silicone insulator, preferably a spray.



The injection of silicone for the gum mask takes place through one of the openings. The second opening is the venting channel to avoid closing air bubbles in the mask.



The silicone gingiva mask made of Picodent Majestik Gingiimplant reproduces the soft tissue system.



To improve the stabilization of the mask, you can create additional cavities before silicone injection. Repeated removal and putting on the mask should not affect its condition.



One-time final hybrid abutments have been made based on Variobase (Straumann/Basel/Switzerland) and zirconia oxide (Kuraray/Noritake Katana HT 12)



Bonding of the titanium base with zirconium oxide with Kuraray / Noritake Panavia V5 opaque cement.



The temporary bridge design was made in the Exocad software after scanning the position of the abutments on the model. The bridge was milled with a reduction and veneered with a composite material (Bredent Bio HIPC, color A2).



Bridge veneering using Bredent VisioLign material.



Checking the bridge seating and fitting on abutments. An increased "offset" between bridge and abutments is necessary to compensate discrepancies.



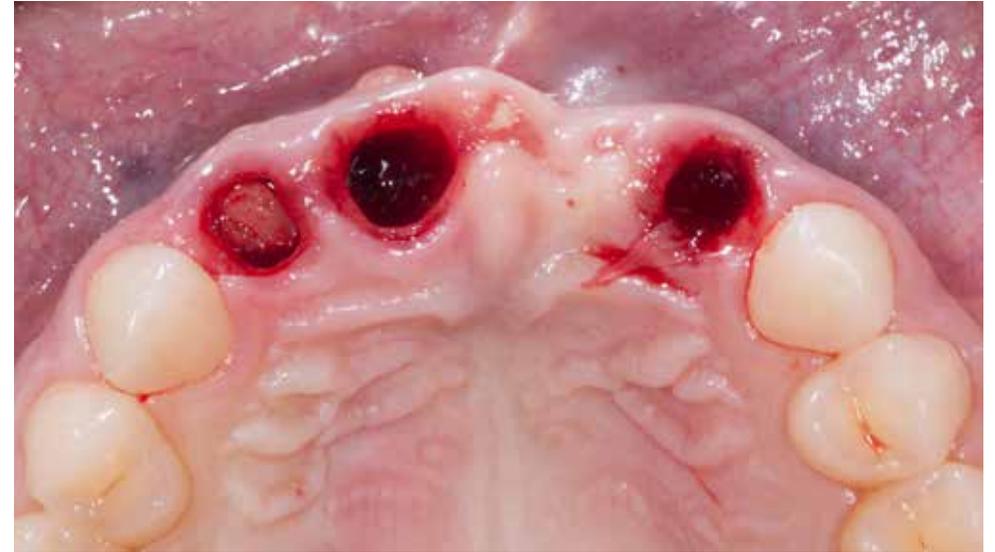
A set of prosthetic elements delivered by the laboratory - the temporary bridge and the final hybrid abutments.







Extraction of the teeth qualified for removal. The tooth 12 was removed in two parts due to the existing fracture. Antibiotic (Clindamycin 600MIP) was delivered a day before the procedure.



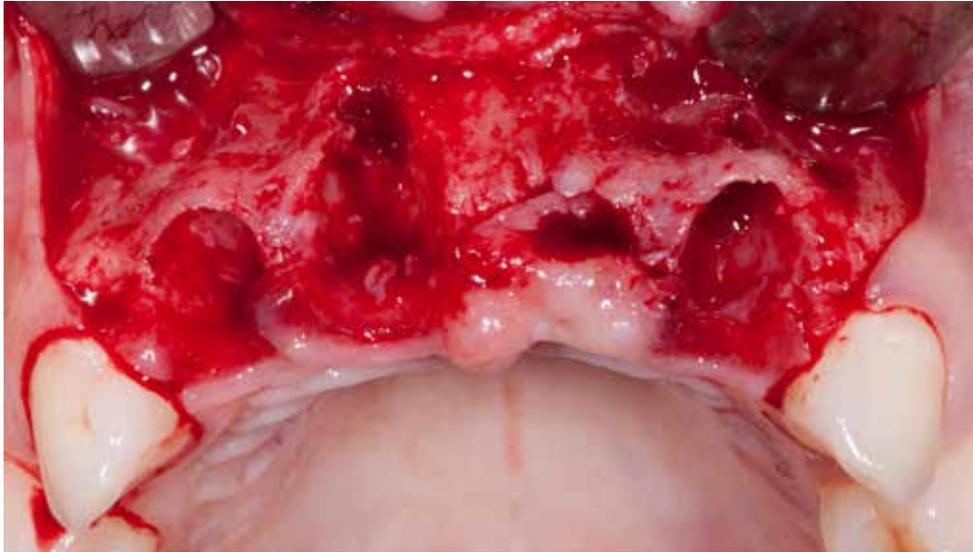
Delicate luxation movements were applied during extraction to not cause additional cracks and stresses within the alveolar ridge.



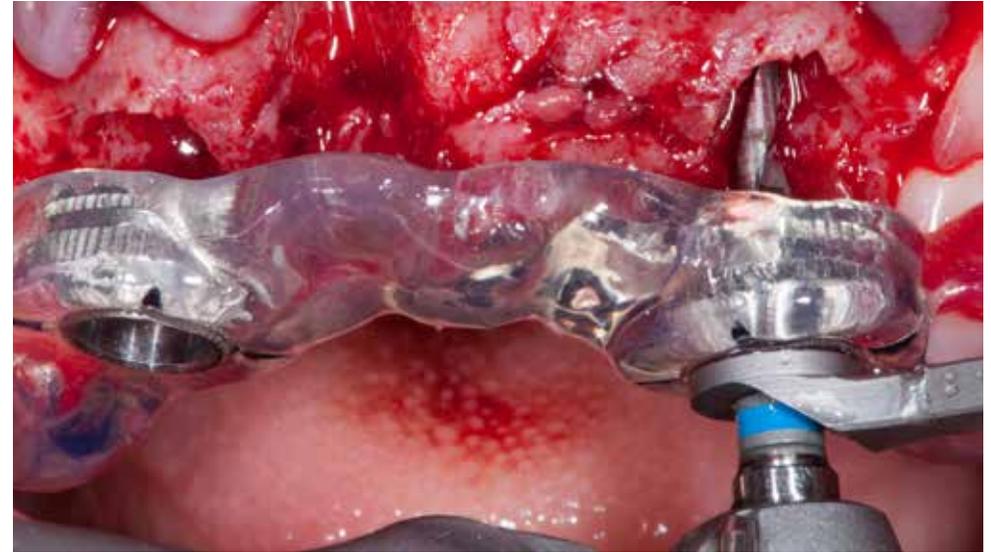
Removal of the lateral incisor root on the right using the Benex extraction system.



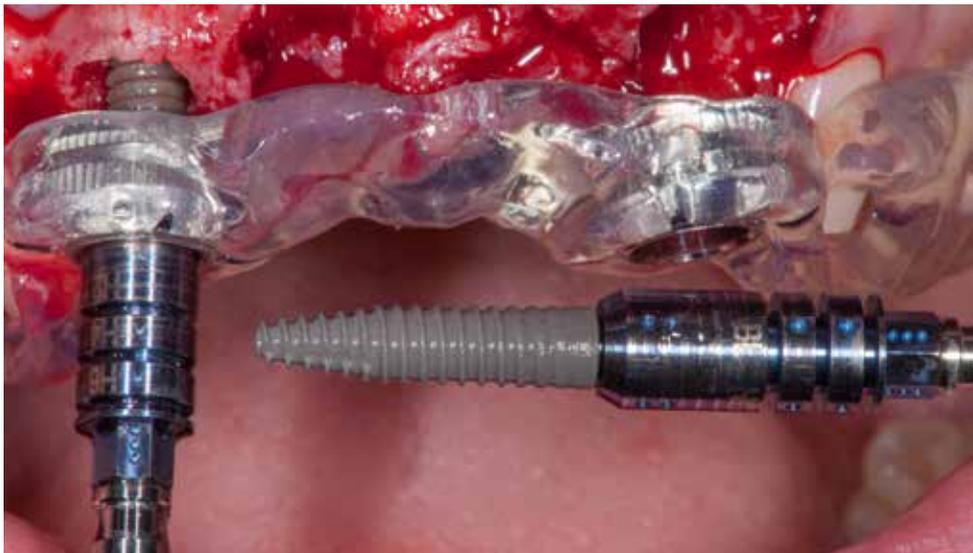
The fitting of a template for navigation designed for immediate implantation is possible only after removing the teeth. Check the accuracy of fitting of the template in the inspection windows.



Full thickness flap elevation from the vestibular side. An incision is made on the top of the ridge through the interdental papillae with the split so that the base of the papilla remains on the bone.



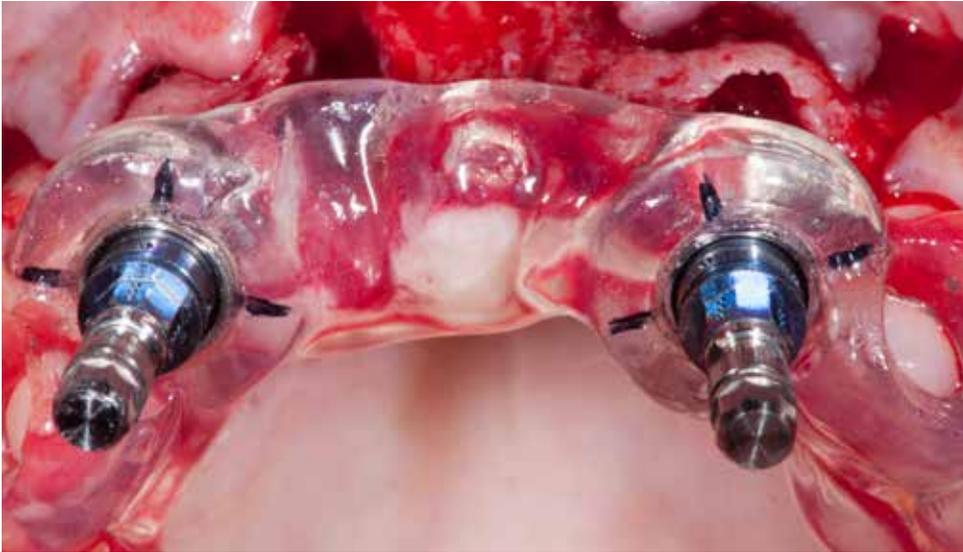
Bone preparation with Straumann Guided computer navigation system starts with the use of 2.2mm pilot drill. The drill has a built-in stopper, and the preparation is at full depth according to the surgical plan.



The Straumann BLT Roxolid Guided implants with the SLActive surface are placed through the template. Thanks to this, the highest precision and accuracy is achieved.



The depth of the implant placement and implant index setting is fully controlled and proceeds precisely in accordance with the plan made in the coDiagnostiX™ program. Primary stability of the implants was above 25Ncm.



The positioning of the implant index is set by aligning the dots on the implant carrier in the same position with the reference line marked on the template (marked in black).



Implant position visible after removing the template and unscrewing the implant carriers. The prosthetic platform is in a perfect place for aesthetics and stability and is moved about 2mm from the vestibular plate.



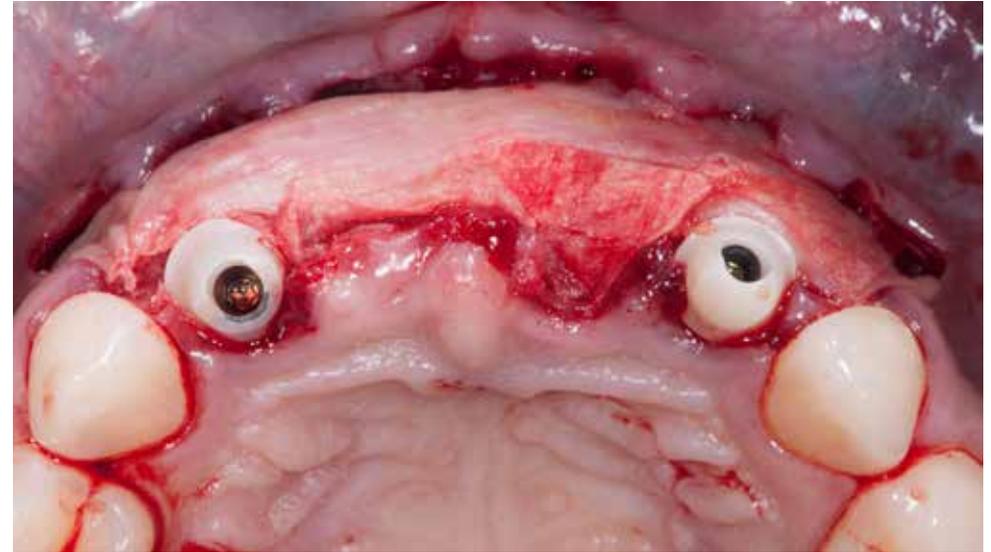
Try-in of hybrid abutments takes place before the start of augmentation. The abutments were tightened with a force of about 15Ncm.



Checking the bridge position to confirm the correct position of implants and abutments.



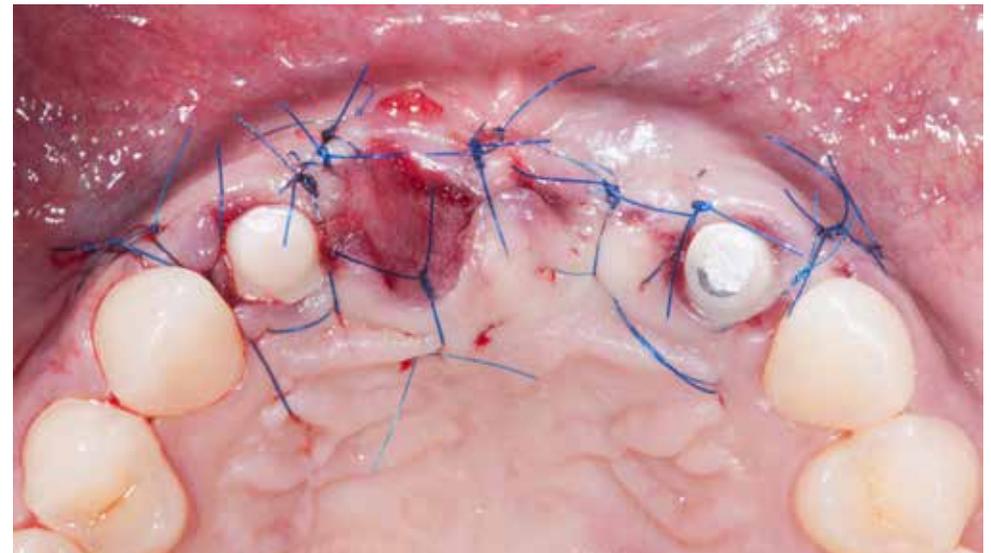
Augmentation of the alveolar process with a mixture of biomaterials: allograft (maxgraft®/botiss biomaterials), xenograft (cerabone®/botiss biomaterials) and the addition of platelet-rich fibrin (APRF).



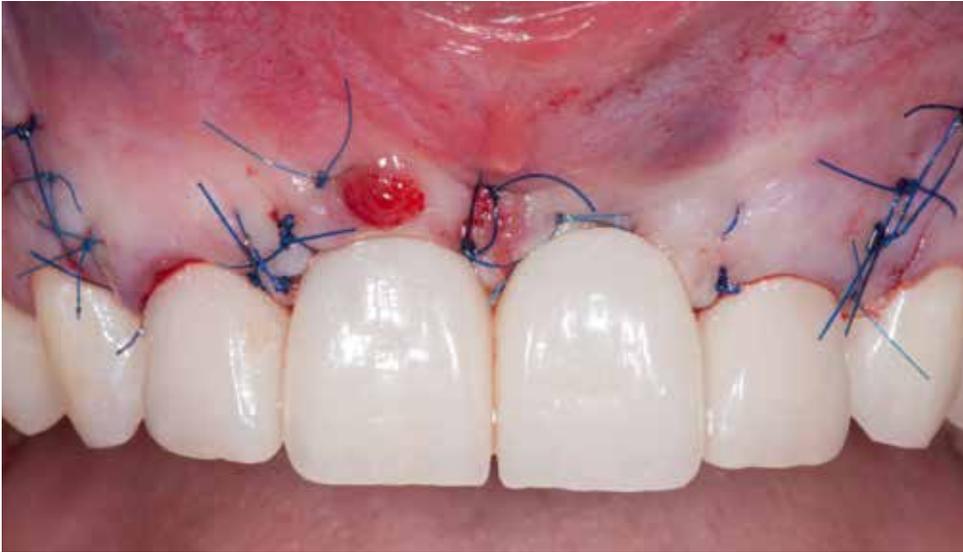
Coverage of the biomaterial with two layers of collagen pericardium membrane (jason® membrane/botiss biomaterials) and additionally an APRF membrane layer.



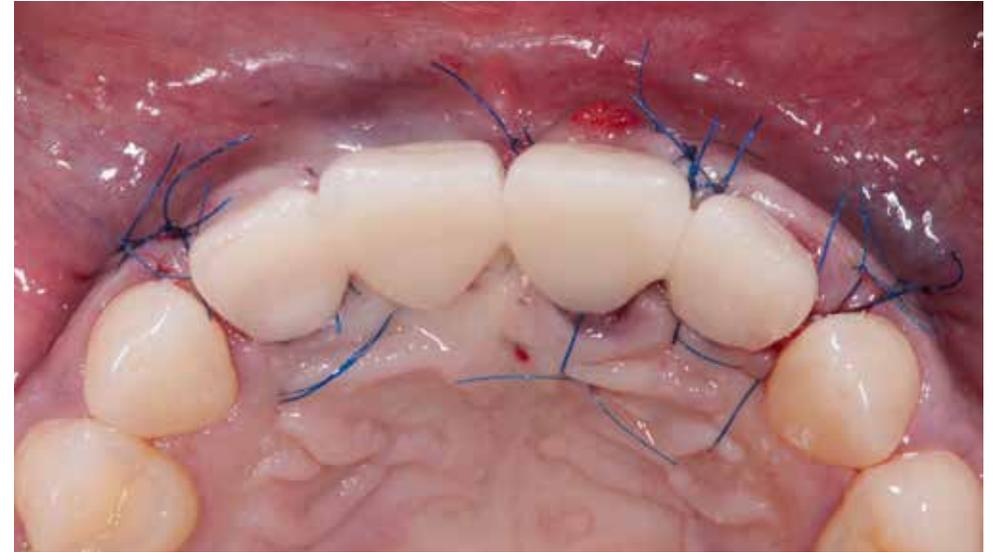
Sewing without tension, 5-0 and 6-0 polypropylene sutures. Entrance to the abutments was closed with Teflon tape. On the vestibular side in position 11, visible remains of an active fistula.



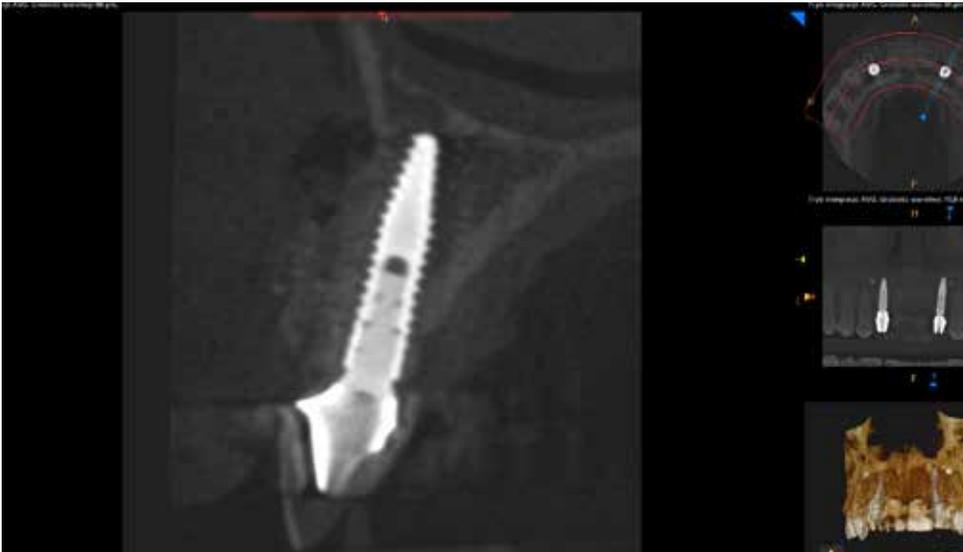
In the site after the extraction of tooth 11, visible open healing with a layer of 3D collagen matrix (mucoderm®/botiss biomaterials) and APRF membranes.



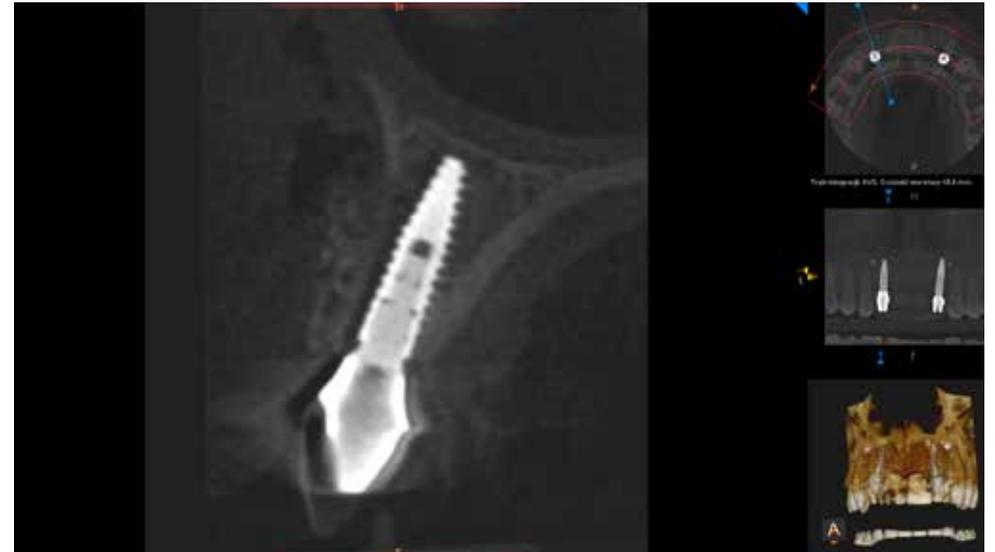
Cementing of a temporary bridge for temporary cement. In positions 11 and 21, the "ovate pontic" have been designed. The shape and color of temporary restoration in harmony with the natural teeth was obtained.



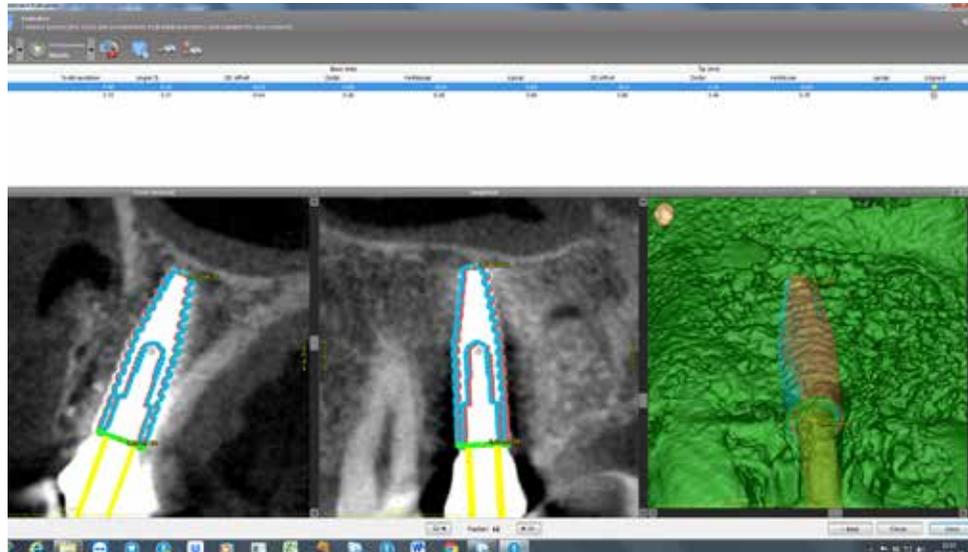
The bridge was completely relieved in occlusion, and the patient was informed about the limitations in the quality of food consumed and the manner of its reception.



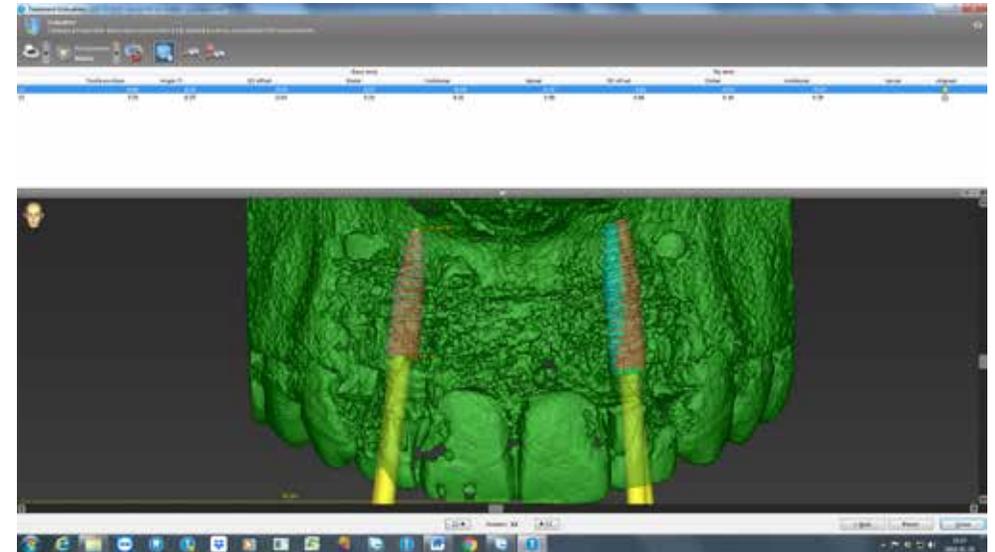
X-ray crosssection in the position 22 to control the implant position.



X-ray crosssection in the position 12 to control the implant position.



Objective evaluation of the precision of the procedure by comparing the planned and the position achieved. Tools from the coDiagnostiX™ program were used. The 3D offset difference is obtained at the level of 0.18mm to 0.23mm.



Evaluation of the implant's position is done by submitting CBCT images from planning and after-surgery. The program calculates differences and gives discrepancies in the form of so-called offset in the area of the apex and implant platform.



Healing process and control appointment combined with the removal of sutures after two weeks from the surgery.



Healing after 4 months from the surgery. Visible soft tissue deficiency mesially at the implant in position 12.



Image of soft tissue healing with a beautifully formed soft tissue imitating the central papilla after 19 months from the surgery.



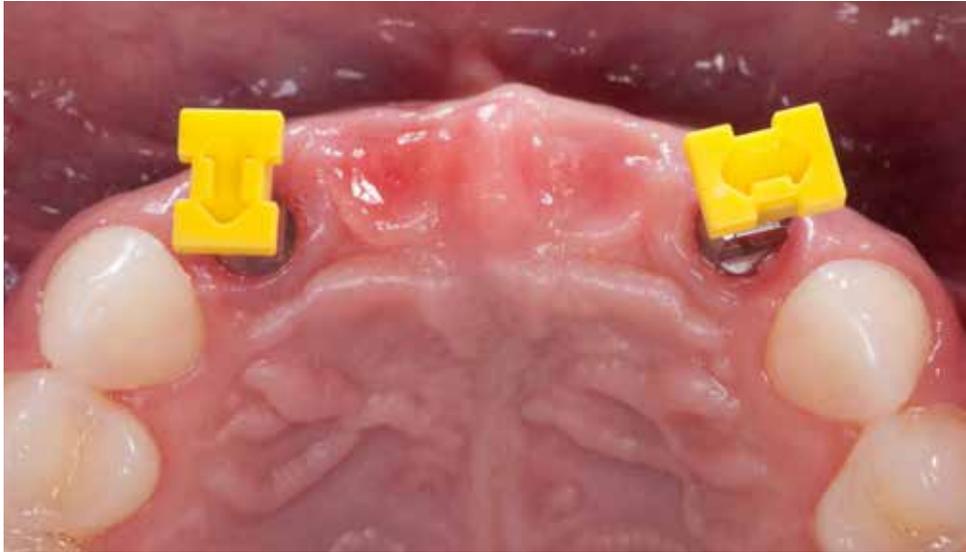
Due to the change in the position of the soft tissue at the abutments, it was decided to change the concept of the prosthetic solution and the decision was made to make a screw-retained bridge.



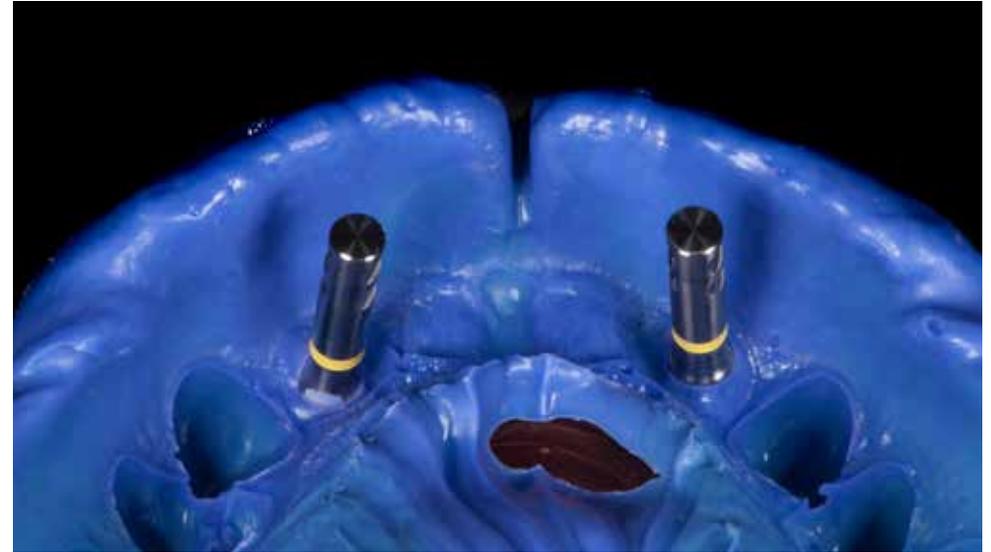
Stable and healthy soft tissue situation within the emergence profile at implants level and in the pontic site.



The closed tray impression technique was used to transfer the implants position.



Mounting of impression transfers and impression caps.



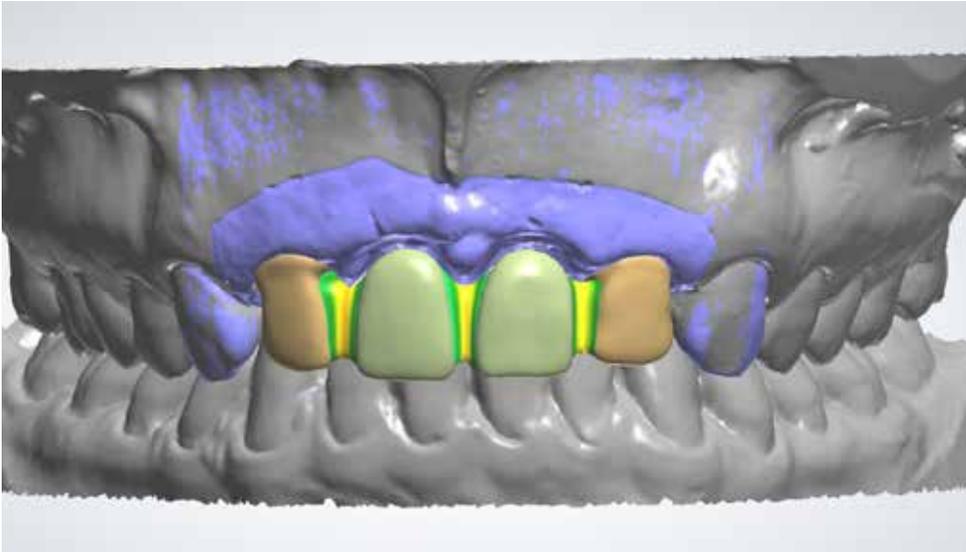
Silicone impression with laboratory implant analogs in place.



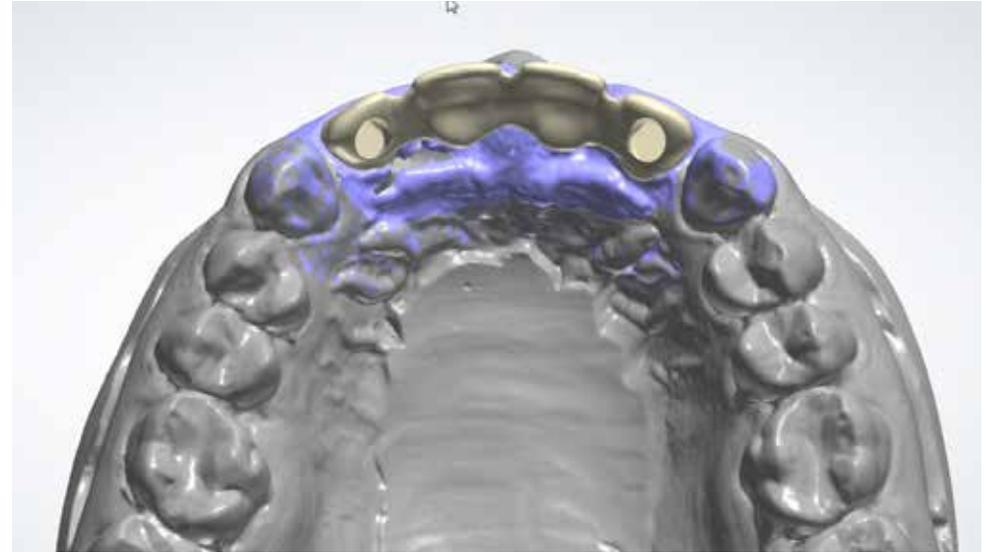
Color information transfer. The picture with a dual flash unit at 45 degrees on the bracket. Color temperature 5500K.



Additional photos were taken with a filter for cross-polarized photography (polar_eyes/emulation.me)



Designing the framework in the Exocad program.



Designing the framework in the Exocad software and changing the prosthetic axis with Variobase AS abutments (Straumann).



The framework was milled from a zirconia disk (Kuraray / Noritake Katana HT 12) and then sintered in a Dekema Austromat 664i furnace at 1500°C for 120 minutes according to the manufacturer's instructions.



Control of the framework on the plaster model.



By aesthetic analysis, it was decided to improve the effect by the addition of two prepress veneers for canines.



View of the work before the installation of Variobase abutments (Straumann).



Variobase abutments were cemented in the construction with the Kuraray/Noritake CZR opaque cement, color A1.



Work set on a plaster model. Veneering the bridge structure and veneers were made using A1 ceramic (Kuraray / Noritake CZR) in the Dekema Austrat 624 furnace in accordance with the manufacturer's instructions.



In the case of Variobase AS (Straumann) abutments, which belong to the group of abutments with a dynamic screw it is necessary to use a dedicated screwdriver and screws.



The possibility of redirecting the prosthetic axis to the implant axis (up to 25 degrees) with the help of the Variobase AS (Straumann) abutments allows performing aesthetic screw-retained work even in difficult conditions.



Image of soft tissues prior to the placement of the final prosthetic work.



The condition and condition of soft tissues indicates a healthy and stable substrate. The thickness of the gingival profile and the shape of the alveolar ridge are the foundation for the aesthetic effect.



View of cemented veneers on the canines and closing the screw access with the Teflon tape.



Closure of the screw channels with flow composite with the A1 color.

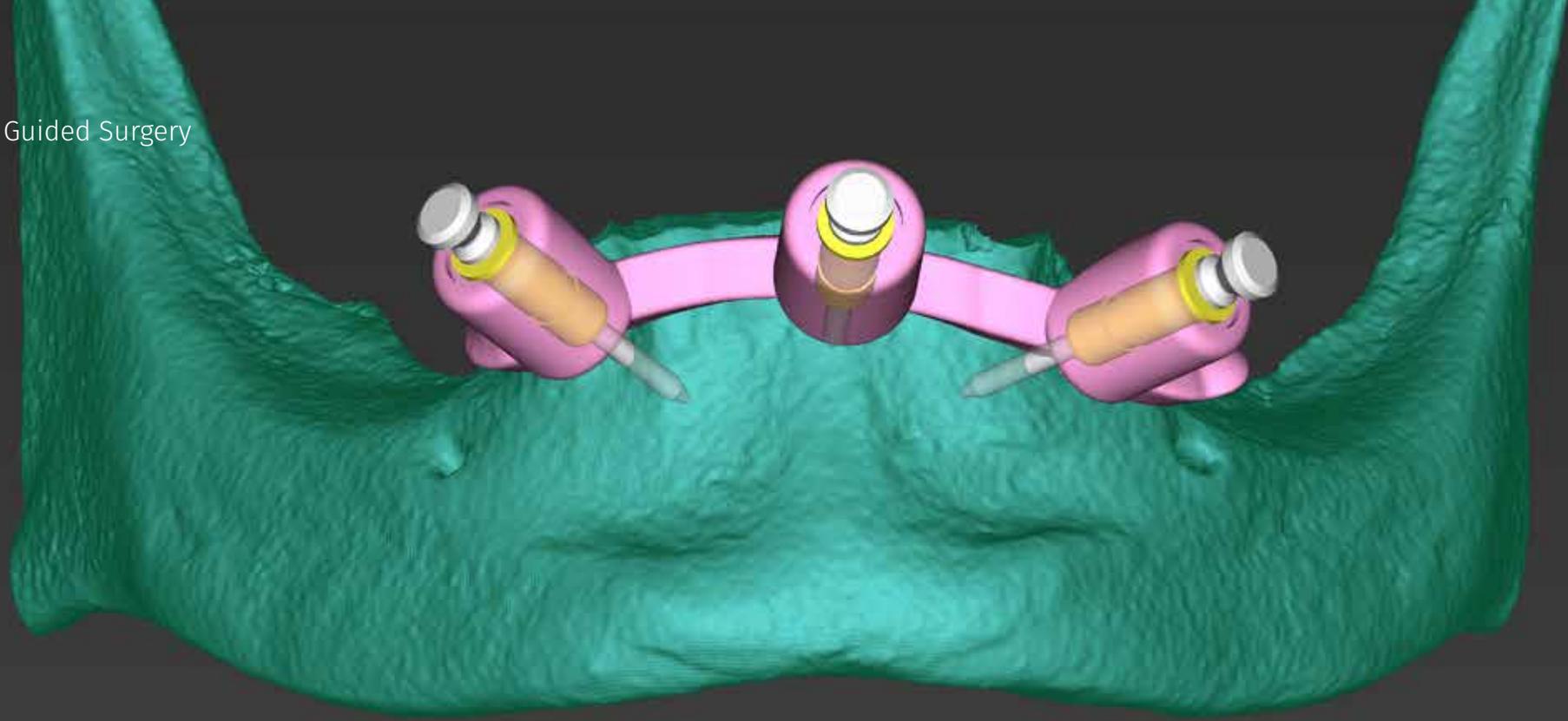


The image after prosthetic treatment was finished.



The condition after 3 years from the beginning of surgical treatment demonstrates a stable and satisfactory result of treatment achieved thanks to precise planning and the use of the latest technologies.





Cae 3

Implantation with bone reduction template

Description :

Diagnosis: Teeth mobility of the third degree in the anterior region of the mandible and extensive bone loss in the molars region,

Treatment plan: Immediate implantation, immediate functional loading

Planing software: coDiagnostiX™ (Dental Wings)

Tools and Materials: bone reduction guide, guide for implantation, Straumann Guided surgery set, Straumann BLT SLActive implants,

Planning, Surgery and Prosthetics

Krzysztof Chmielewski, DDS, MSc

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Dental Technology

Stefan Rempelbauer MDT

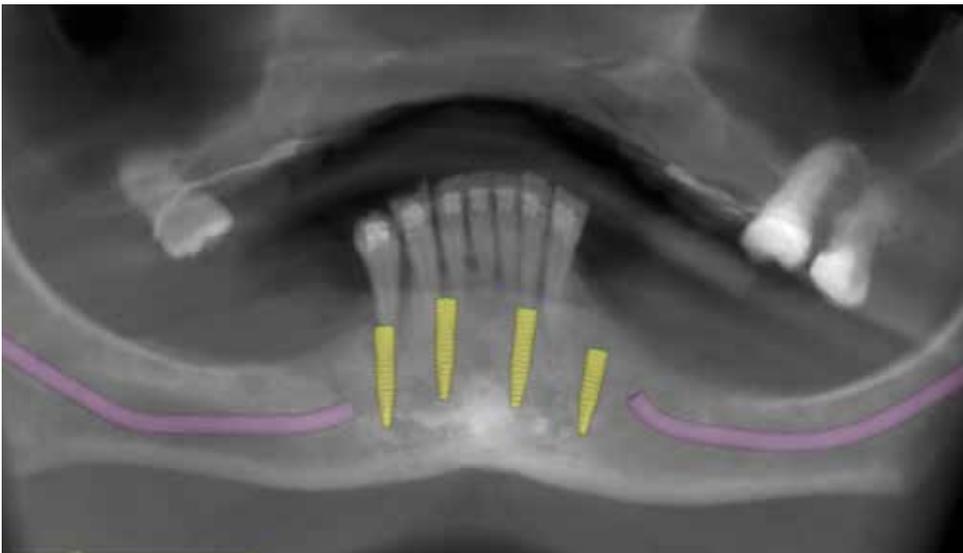
Lenzing / Austria



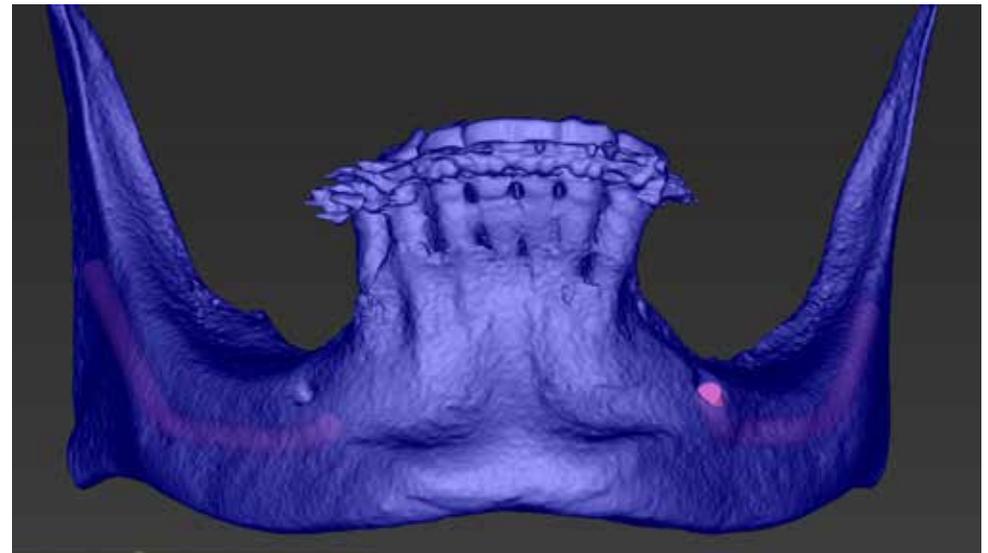
Initial situation. Partial upper prosthesis with clasps on three molars. In the jaw, extensive free end situations. When the patient came to our Clinic, she had an orthodontic appliance.



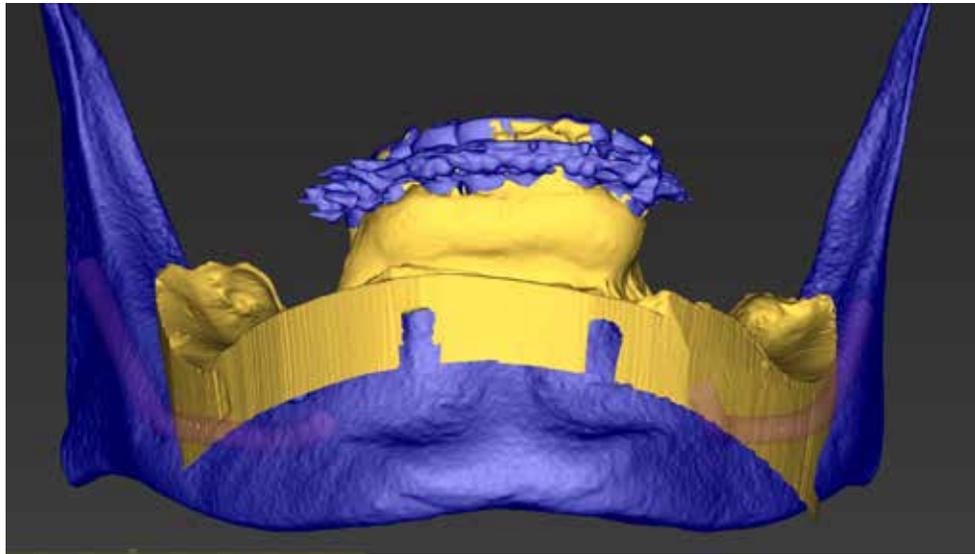
Free end situation and high mobility of the teeth caused by poor bone support in the alveolar ridge were the reasons for transferring to a prosthetic restoration based only on implants in the edentulous situation.



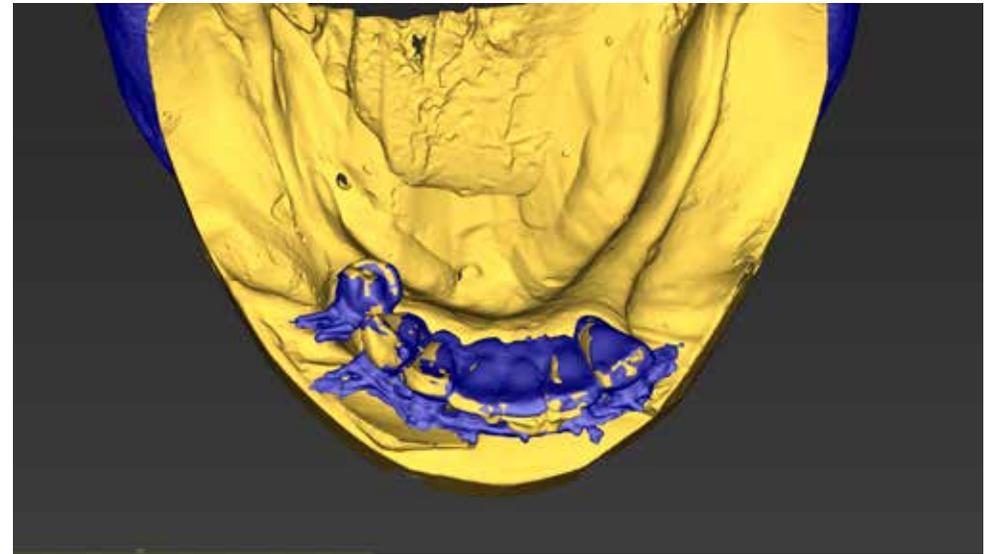
On the basis of intra-oral analysis and bone status, implant planning included the removal of residual teeth in the mandible and immediate implantation of 4 implants in the anterior region.



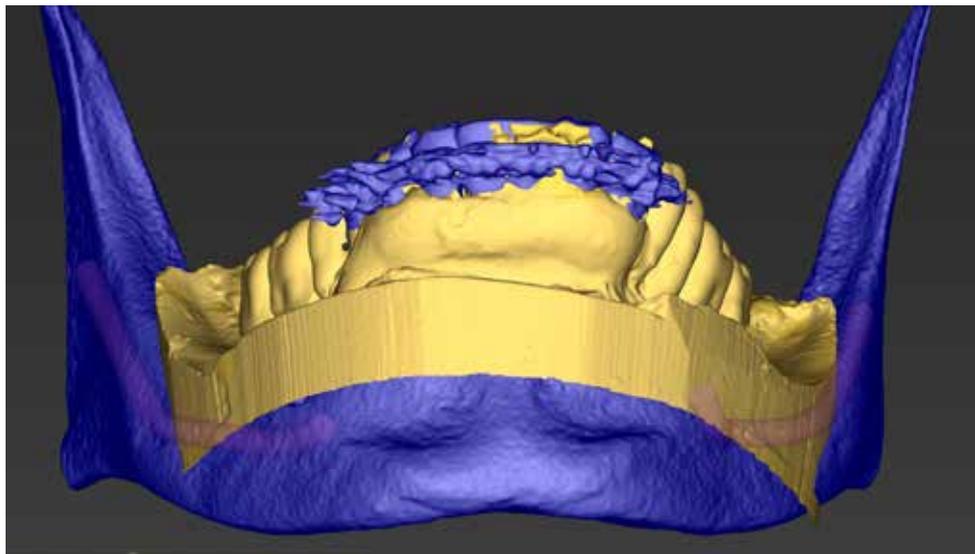
Data segmentation and staining of the bone and teeth layer of the mandible in blue.



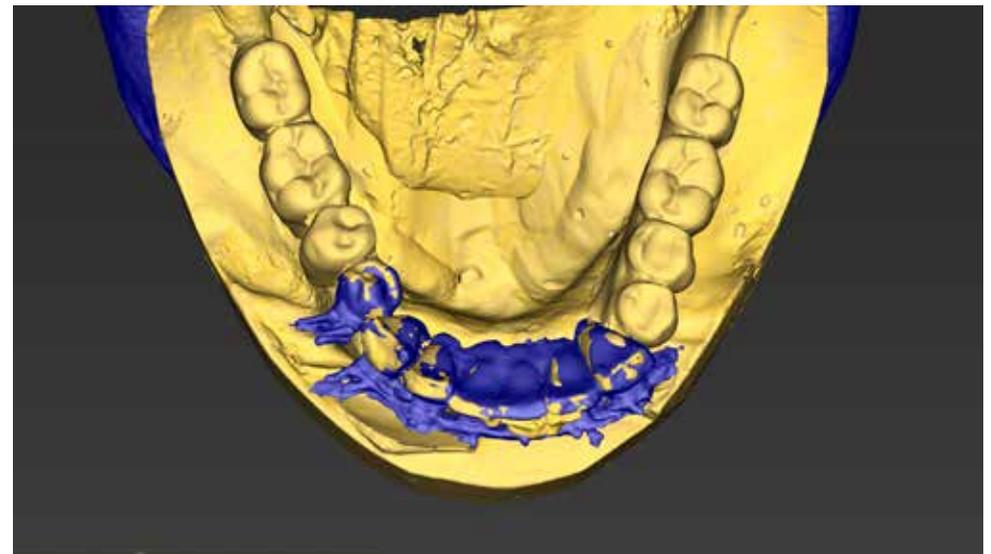
File integration. The plaster model of the mandible was scanned in the laboratory and the STL file was merged together with the images obtained in the Cone Beam Computed Tomography (DICOM) examination.



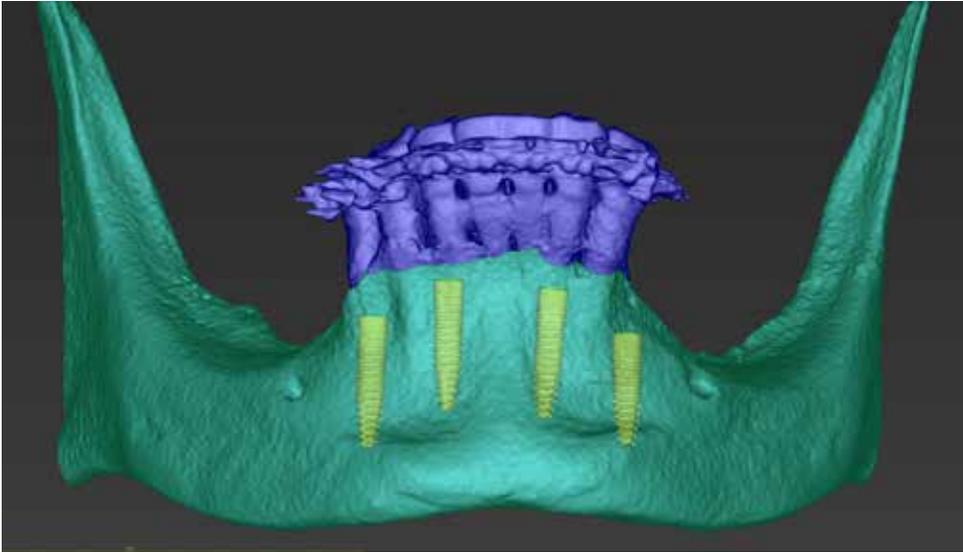
In the case of free end deficits, it is recommended to take a CBCT examination with a radiological template with x-ray markers for optimal data integration.



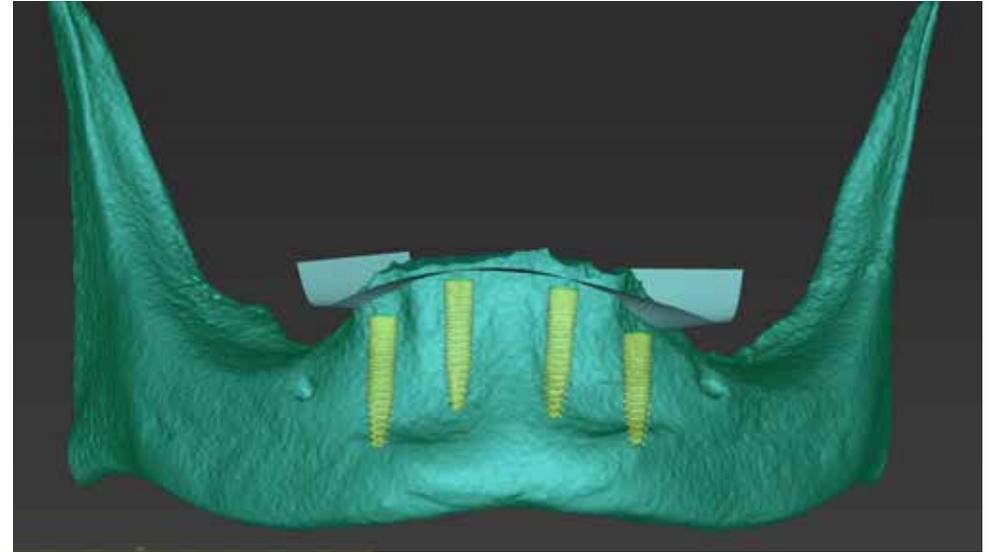
Merging of another layer with STL image by adding another scan with the wax-up model of the missing teeth.



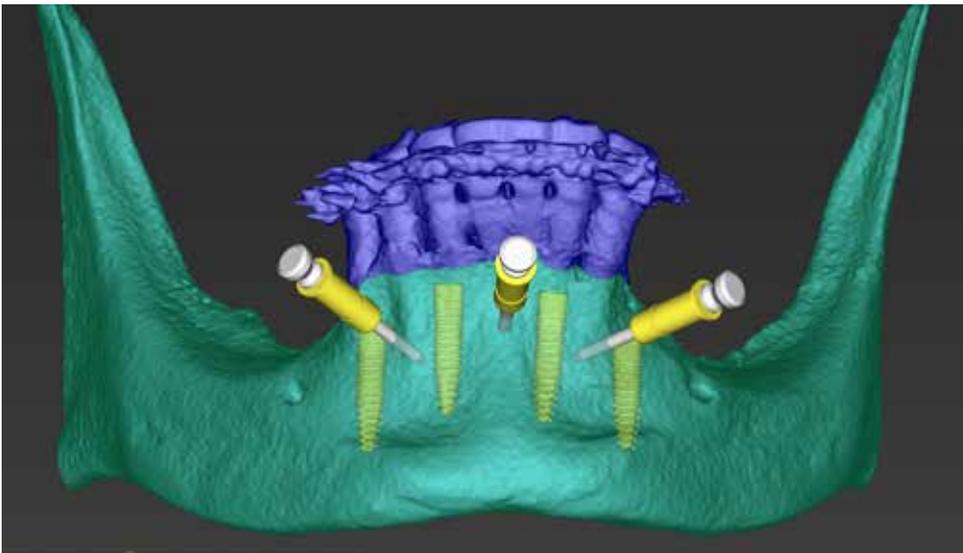
It is easy to create a wax-up for temporary prosthetic work by setting the denture teeth in the existing patient's bite. An integrated second scan with the wax-up is visible.



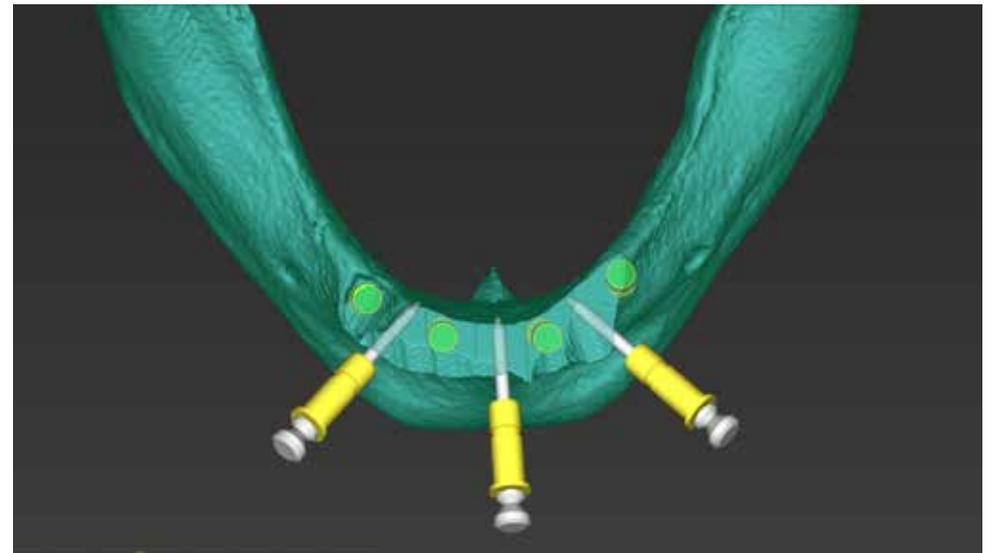
The process of planning the position of implants depends on the available bone volume and the type of temporary restoration – the visible layer of mandibular segmentation is stained in green.



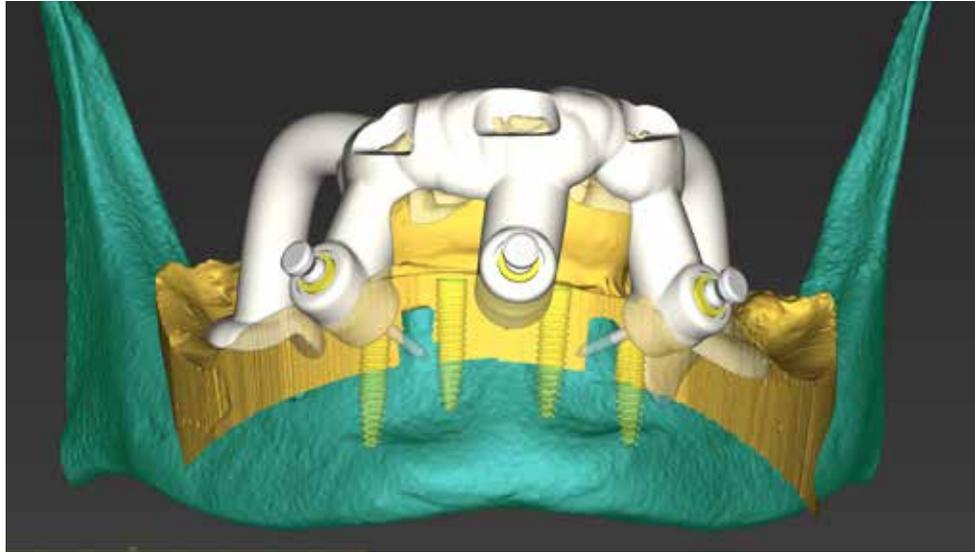
In order to optimally position the implants, a plane was established to reduce the bone level, the excess of which resulted from the adaptive process.



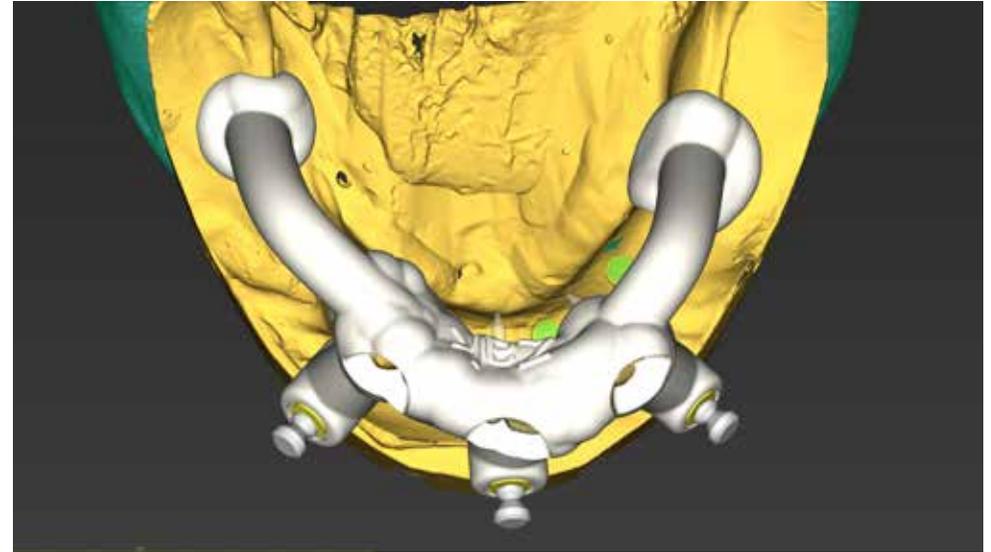
Implantation in the edentulous mandible or with extensive tooth loss requires planning an additional stabilization of the template on the bone to avoid displacement during surgical procedures.



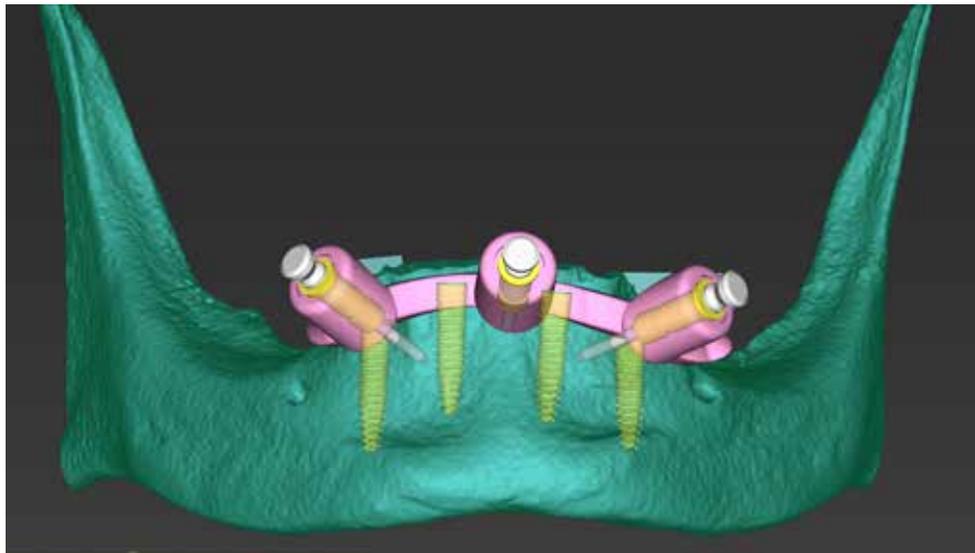
Three pins to stabilize the template are planned in the spaces between the final implants. Their position must include safe distances and proper anchoring in the dense bone.



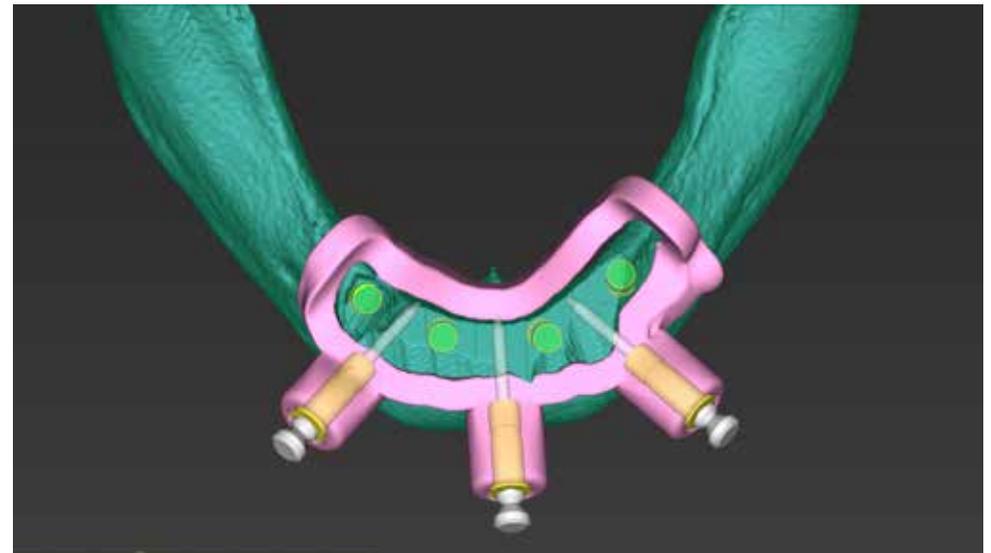
Performing the procedure precisely required three templates. The first tooth-based template is used to drill holes for the stabilizing pins.



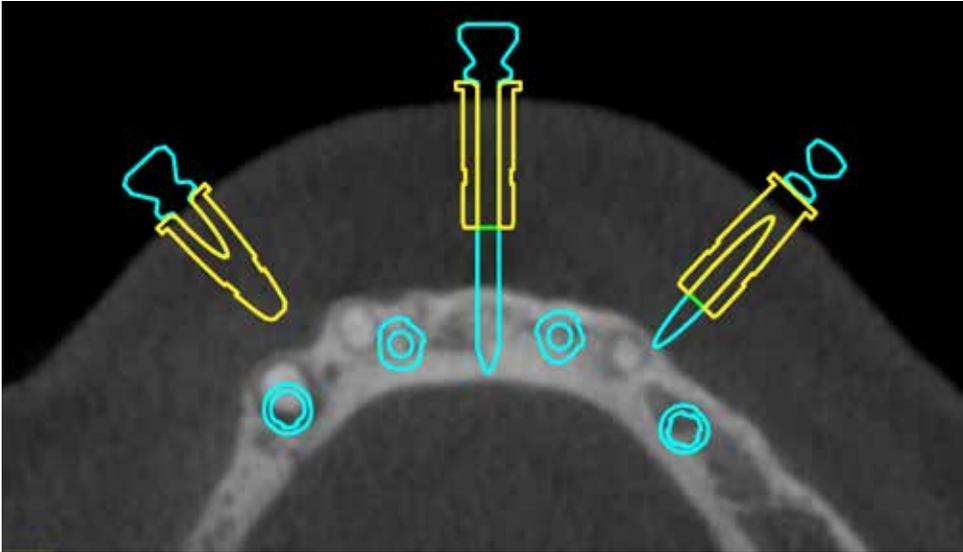
The first template is based on the teeth in the front section and on the mucous membrane in the distal region.



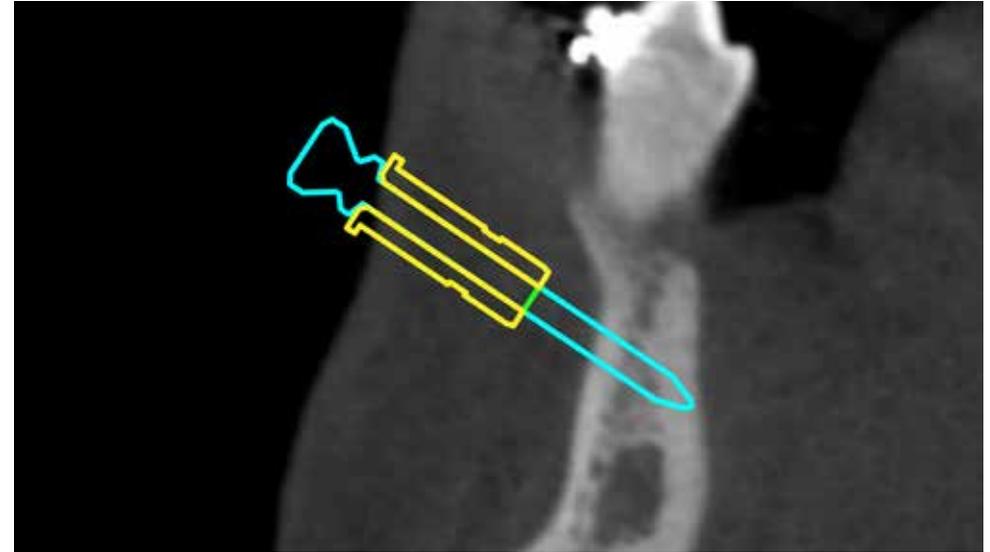
The ability to disable individual segmentation layers allows you to plan the next template. The bone reduction template in the front region of the mandible is fixed with pins in pre-prepared places.



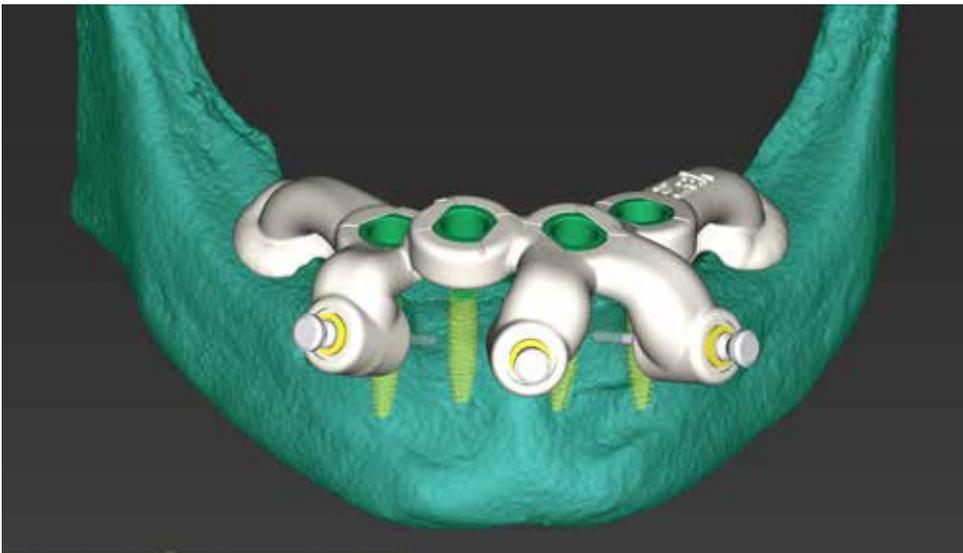
The window in the reduction template is a planned reference for the surgeon to perform bone reduction during the procedure.



The position of the stabilizing pins is selected based on the available bone, the space between the planned implants or teeth and the insertion axis.



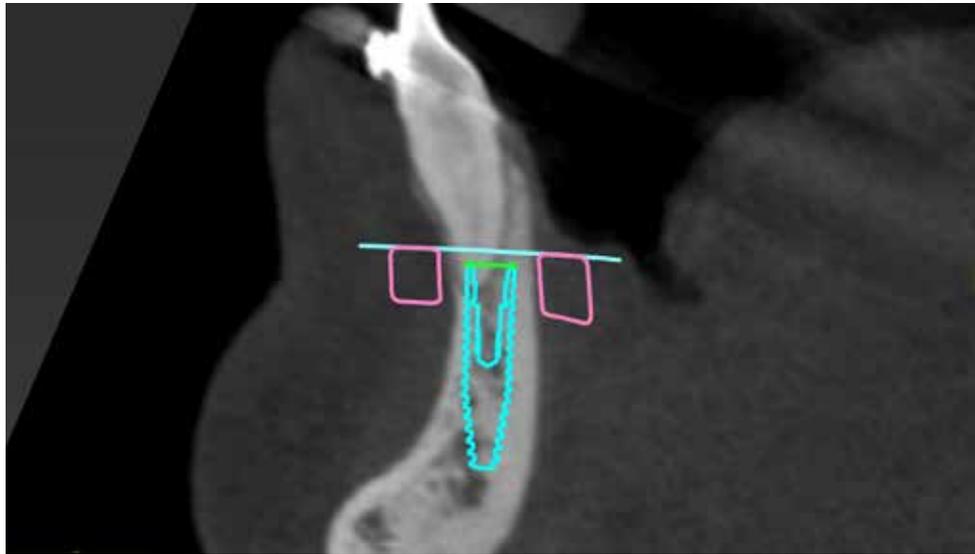
The angulation of the stabilizing pin takes into account the depth of the vestibule and the technical aspect of its seating. The picture shows the pin with the sleeve (yellow color). Mucous thickness determines the distance of the sleeves.



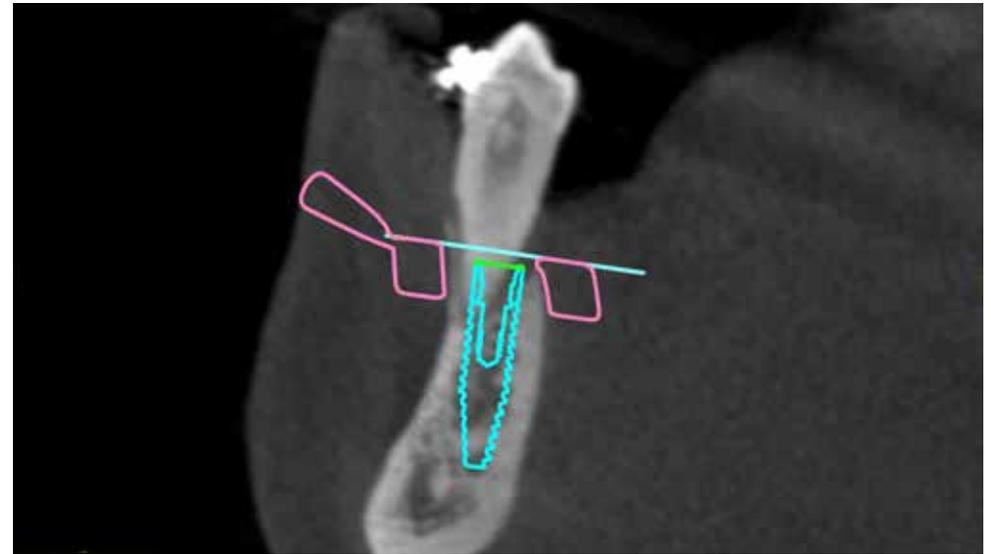
The third template planned in this case is the template for Straumann Guided protocol. It will be used for the osteotomy preparation and for implants placement through the guide.



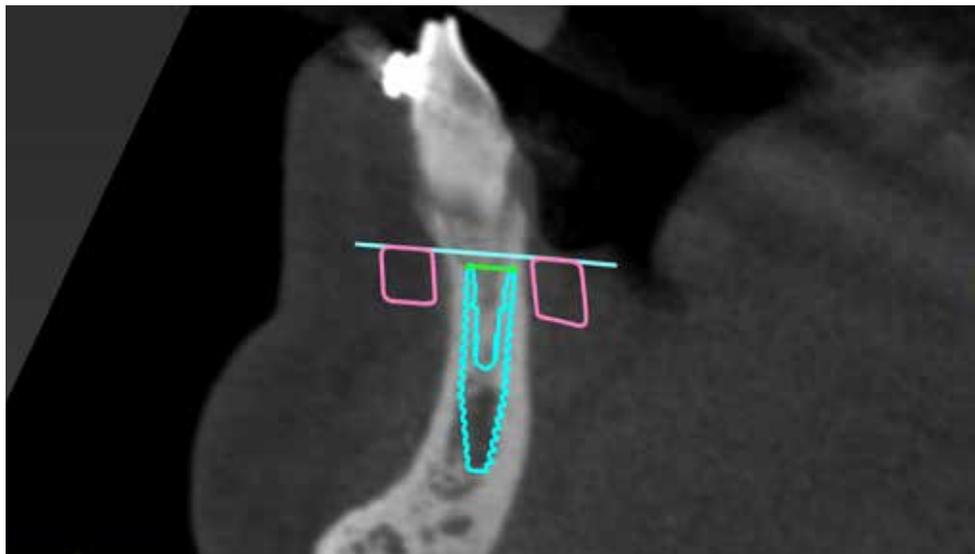
The template for full navigation has dedicated titanium sleeves with an internal diameter of 5mm. The reference positions for the index in the implant will also be marked on the template.



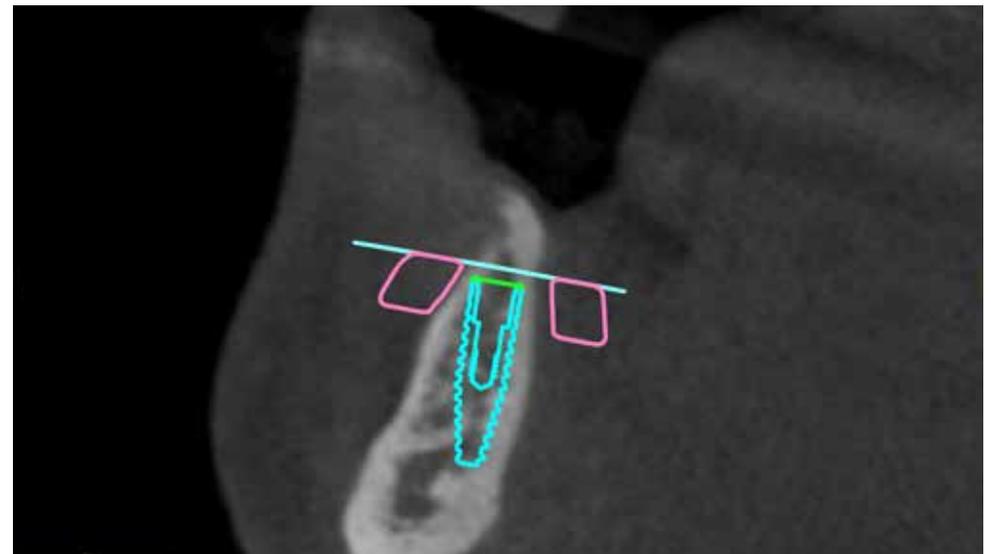
Position 42 - The location of the planned Straumann BLT NC Roxolid implant (diameter 3.3mm and length 14mm) as well as the bone reduction plane and the cross-section through the reduction template (pink color) are visible.



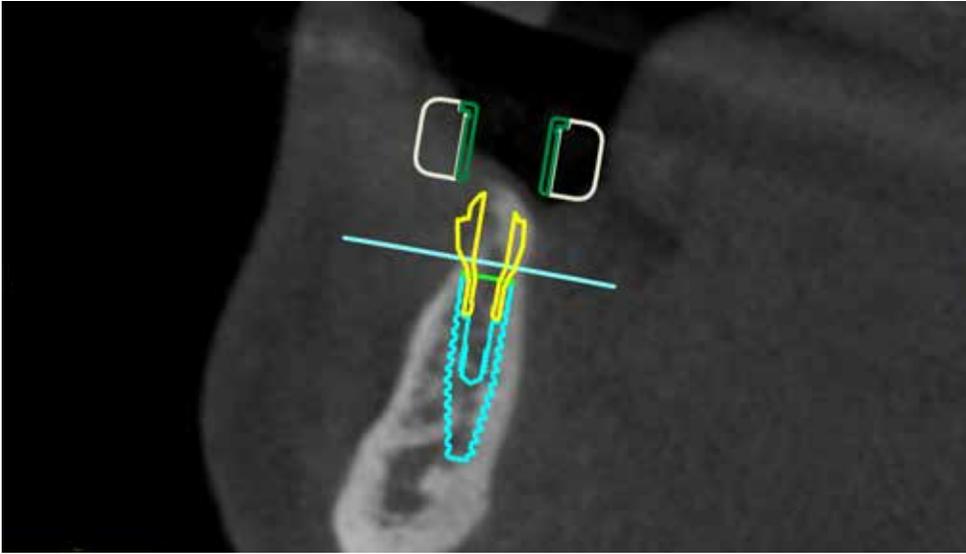
Position 44 - bone reduction level varies in individual cross-sections. The implant will be inserted in the alveolar ridge with the safety bone volume around the implant.



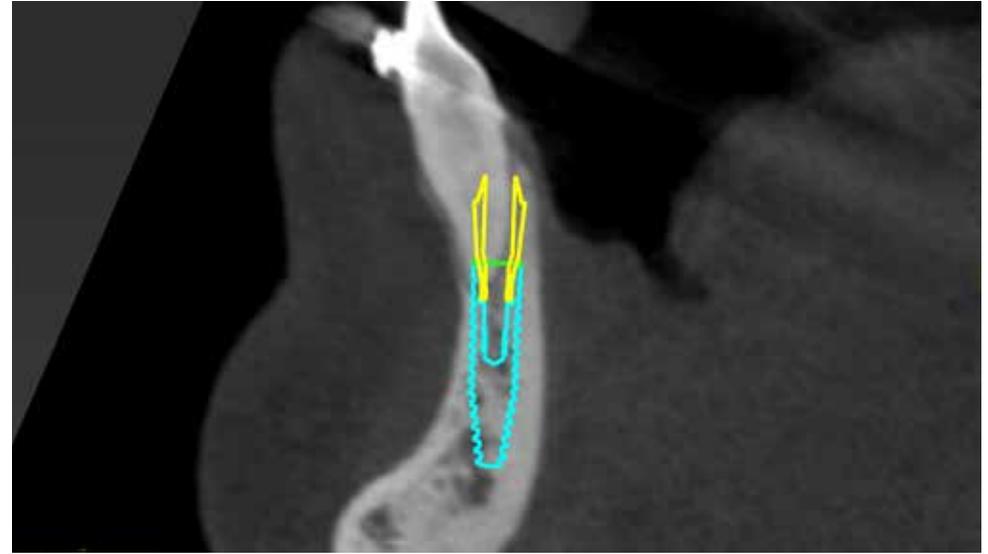
Position 32 - length and diameter of the implant take into account the possibility of planning an immediate functional load. Places with reduced bone density may affect primary implant stability.



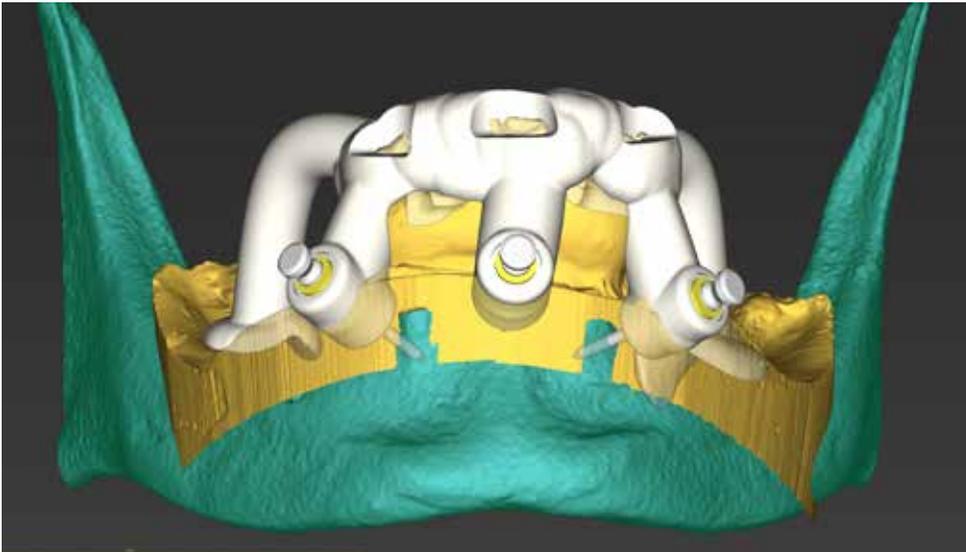
Position 35 - late implantation on the left side in the mandible. Reduction of the ridge gives a safe volume of the bone around the implant at the level of the top of the ridge.



Planning in the coDiagnostiX™ software enables selection of the Straumann BLT NC implant, an abutment for screw-retained restoration and the selection of its gingival height and angulation.



In position 42, an abutment for screw-retained restoration with a diameter of 3.5mm is planned. The small diameter with a straight abutment leaves a larger volume for the temporary restoration around the temporary sleeve.



Template design for positioning and drilling for pins for anchoring the template to the mandibular bone. Prepared holes will be used to position the other two templates.



A ready template printed in PolyJet™ technology on a Stratasys printer. Visible are sleeves, which are guides for drills and pins.



Printed bone reduction template. The resin used for the production of this type of templates (Stratasys MED610) must meet the highest rigors of safety and have appropriate approvals.



The window in the template will allow you to position the template to create a reference for the alveolar bone reduction.



Printed template for osteotomy and implant placement.



All sleeves are positioned with the press-fit. Printing technology will influence the offset setting.



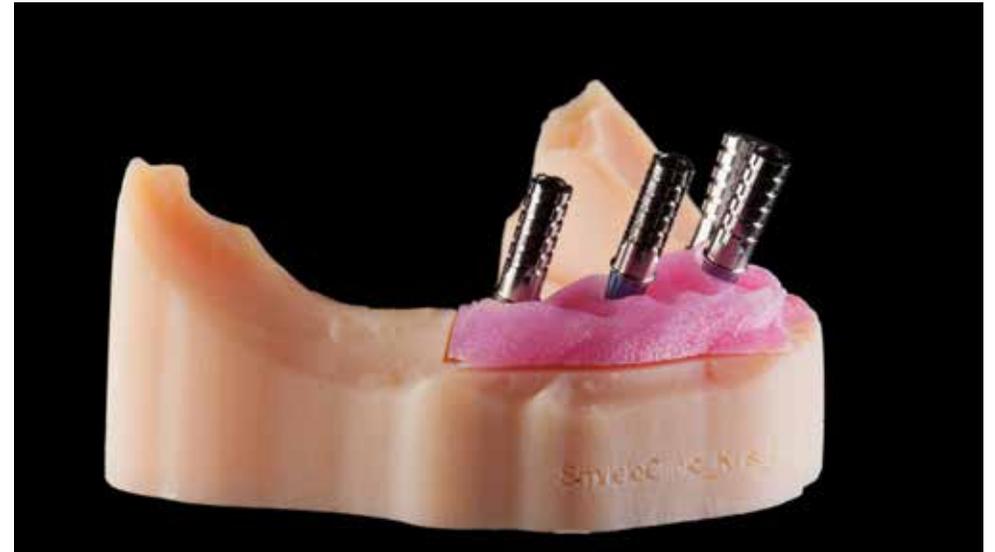
Based on STL files and planning the position of implants, a model with a soft tissue mask and embedded implant analogs were created before the procedure.



The model has been printed and consists of three elements: a model base, analogs, and a removable elastic gum mask.



The position of the implant analogs is related to the depth of implant placement according to the plan and the position of the index. The picture shows the Straumann abutments for screw-retained restorations on the Straumann BLT implants.



Checking the position of the temporary sleeves to fix the temporary restoration.



Prepared temporary work. The bridge is made of PMMA material that will be connected to the sleeves in the oral cavity. View from the lingual side. The distal stabilizing supporting elements are visible in the molar region.



The reference for the temporary restoration was the position of the natural teeth. The optimum position for the prosthetic axis was taken into account during implant planning. Access to the screws is from the lingual and occlusal side.



Try-in on a printed model of abutments, temporary sleeves, and temporary restoration.



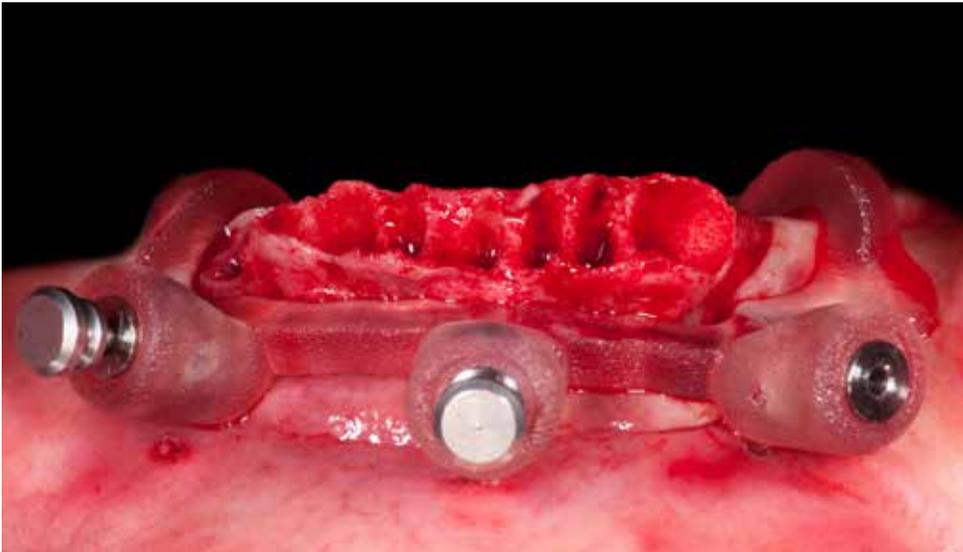
The prepared holes in the temporary restoration give the space for the material to connect the temporary sleeves.



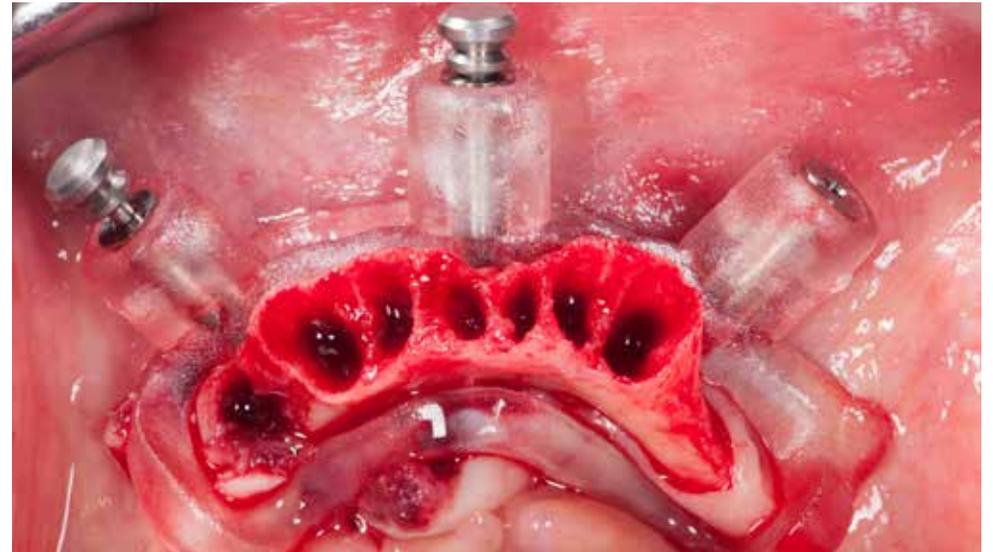
The situation before surgery. The administration of anesthesia in the vestibular part and on the lingual side of the dentition is sufficient for this type of surgery.



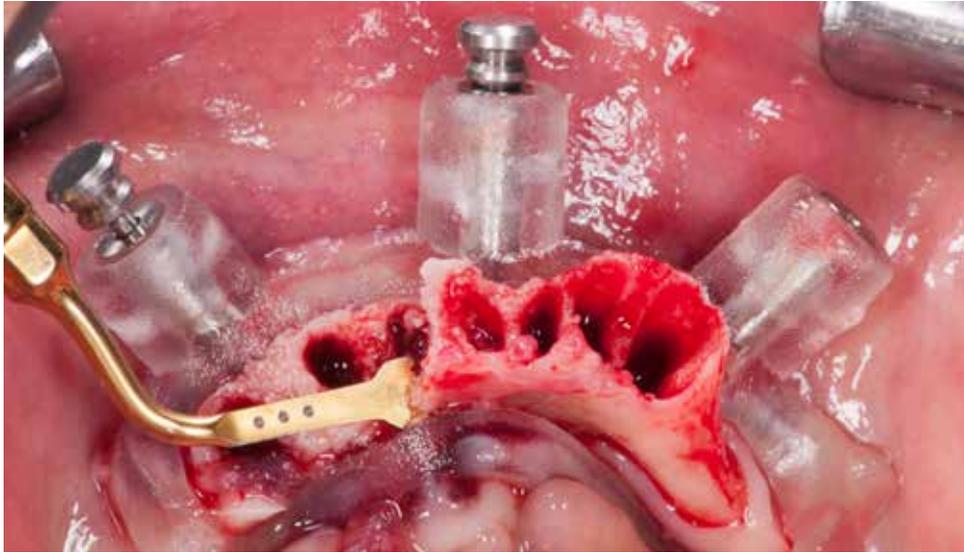
Setting the template on the patient's teeth and after drilling through the sleeves, placing the stabilizing pins to check the stability of the guide.



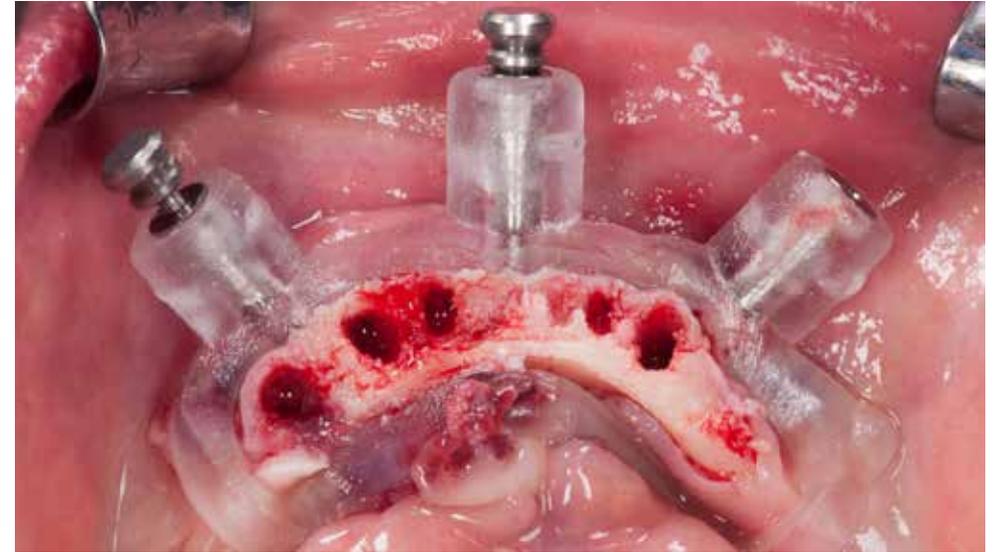
After removing the teeth, the full thickness flap is raised, and the bone reduction template is placed. The template is fixed by stabilizing pins.



The window in the template determines the level at which the bone reduction will be carried out.



Bone reduction using a piezo surgery (Mectron). The type of tools used depends on the operator and we can use for this purpose drills, bone saw as well as chisel and Luer type bone forceps.



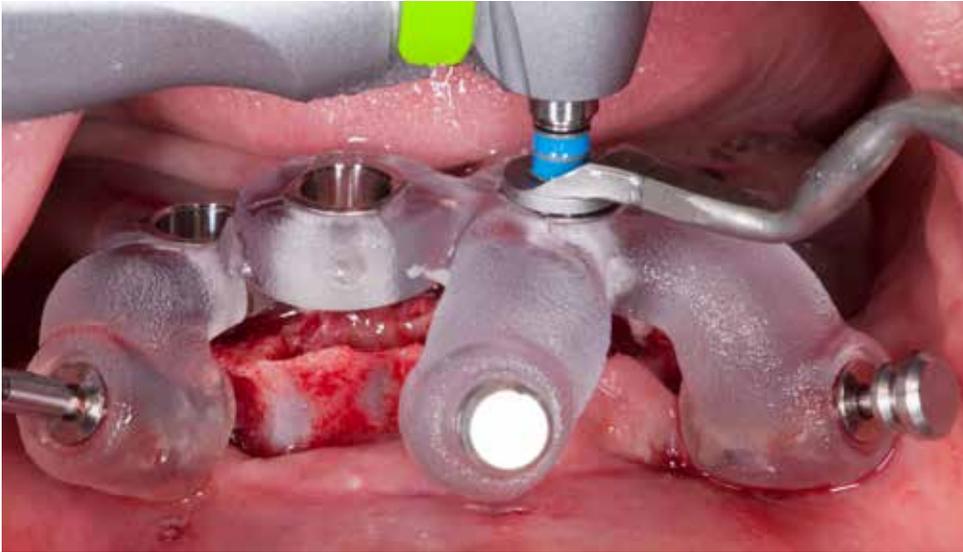
After the bone reduction is made, the basis for preparation for the implants is revealed.



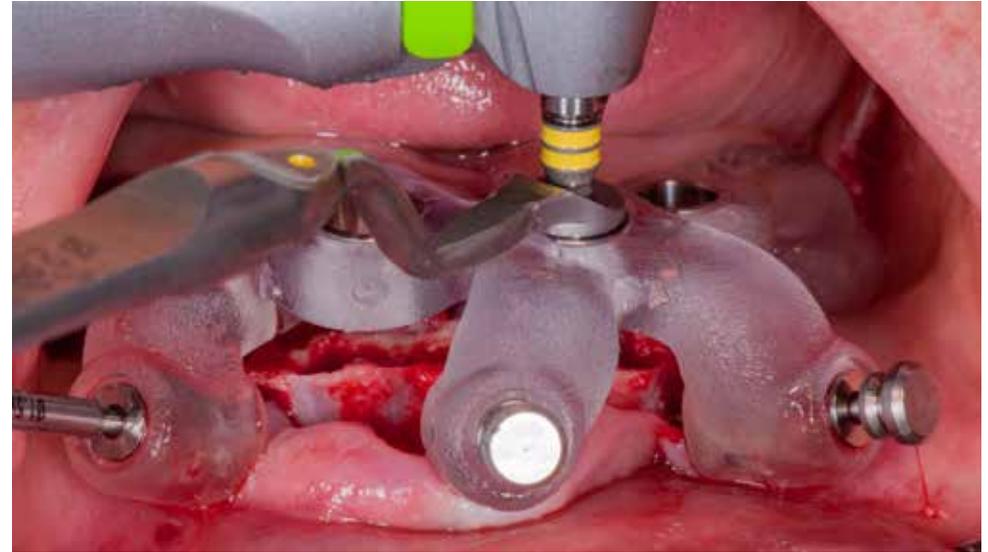
Setting the template for full navigation and stabilizing it with pins in the bone.



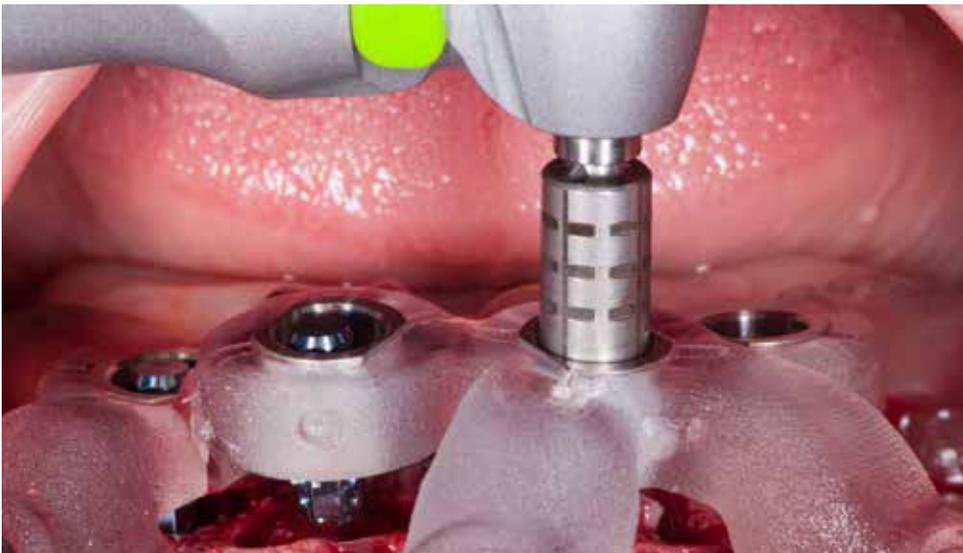
Guided surgery with the Straumann Guided instruments follows the surgical plan generated in the coDiagnostiX™. View of the handle for the pilot drill embedded in the template sleeve.



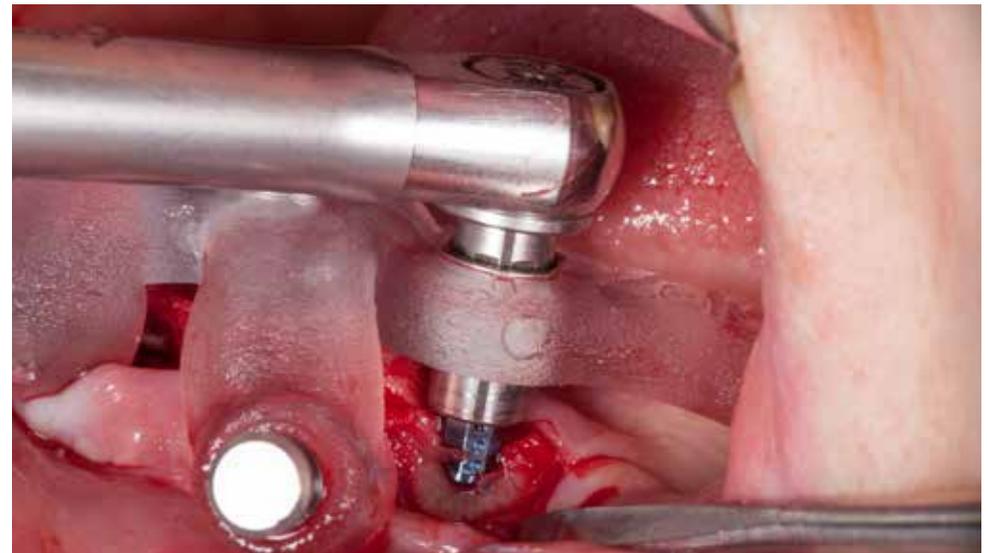
The pilot drill preparation is to the full depth until the drill stops on the collar of the drill holder. Three lengths of the drills are available and the correct size is given in the surgical protocol.



Osteotomy for the Straumann BLT NC implant is made with two drills: a pilot drill (2.2mm) and a drill with a diameter of 2.8mm. The drills sequence is also given in the surgical protocol.



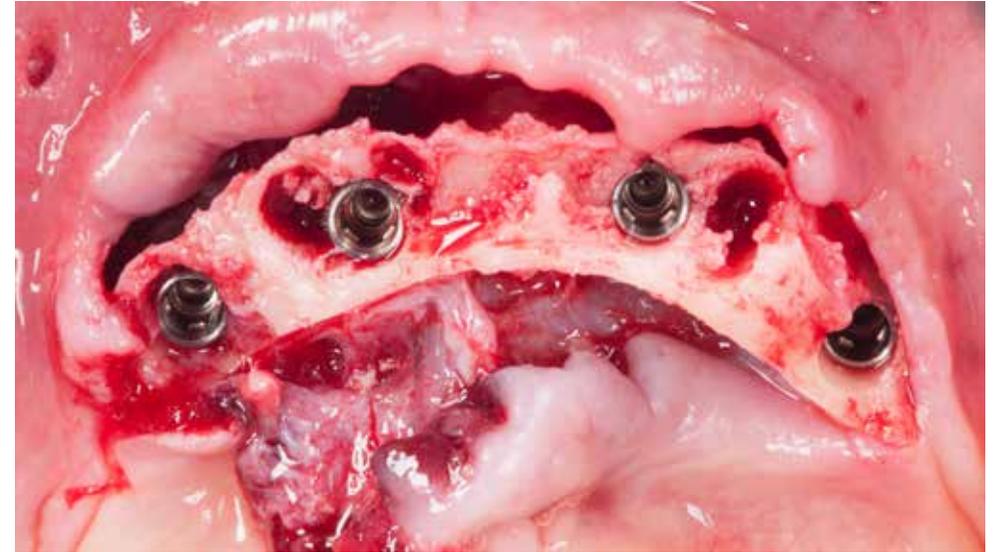
The Straumann BLT SLActive NC implant placement through a template with the help of a dedicated adapter. Horizontal lines are a reference for the depth of implant placement. The vertical lines are indicators for the position of the index.



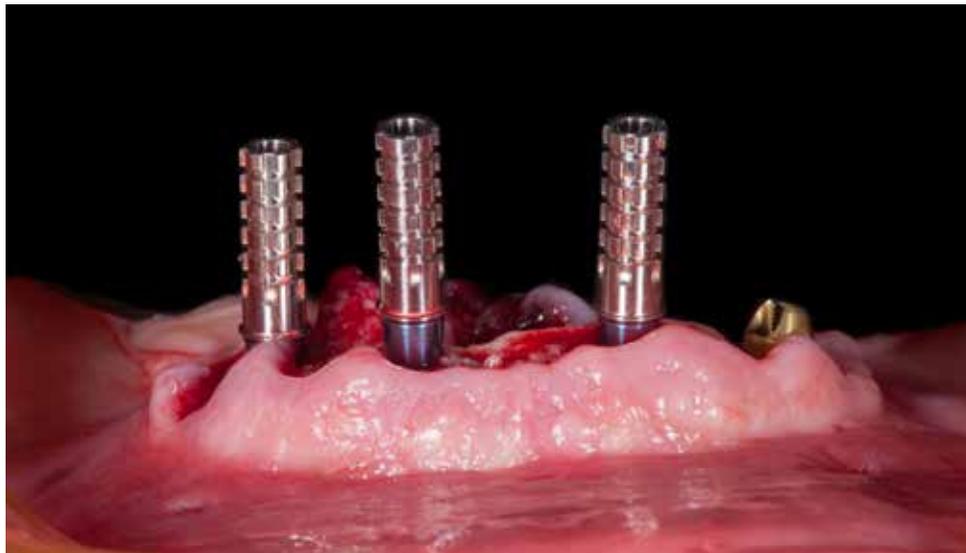
Implant in position 35 - final position reached after insertion of the implant. A depth of seating and index position (Loxim implant carrier) is following the plan.



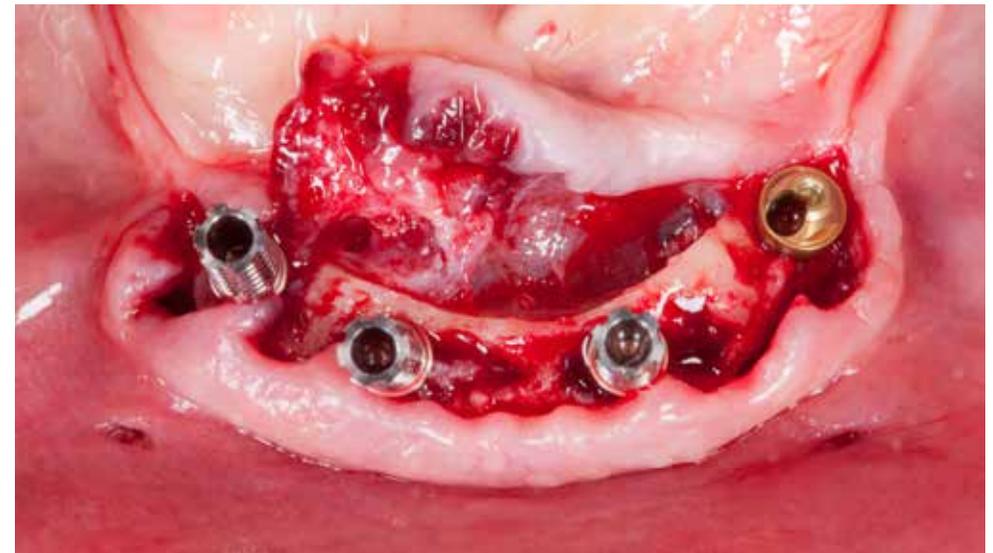
Implants inserted into the bone according to the surgical plan. Loxim implant carriers are at the same time an indication of the depth of implant placement in the bone.



The precision of insertion of implants in the alveolar ridge is visible. The volume of bone around the implant platforms is also visible.



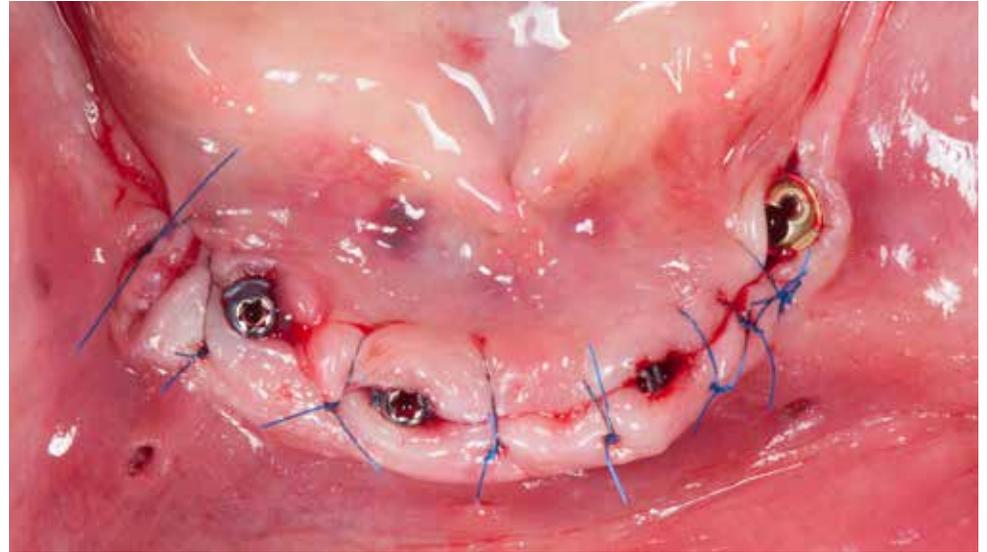
Abutments for screw-retained temporary restoration in place. Straight abutments with a diameter of 3.5mm (blue color) and temporary sleeves are in place, and an angulated 17o abutment in position 35 is visible.



The position of prosthetic elements from the occlusal view. The flap was not additionally mobilized.



Try-in of a temporary bridge. The span of the bridge restores the ten teeth.



Suturing the soft tissue without tension with 5-0 monofilaments.



A flow light-cured composite can be used to connect the temporary restoration with sleeves or use another acrylic-based material.



Restoration in place. The sleeves are sealed with a Teflon tape and closed with a flow composite.



Temporary restoration fixed to the implants.



The healing process after 2 weeks from the surgery.



After a period of 3 months, temporary work was unscrewed and the condition of soft tissues was assessed.



During the healing process, the level of soft tissue is stabilized around the abutments. In the case of screw-retained restoration, the replacement of the abutments due to the soft tissue height change may be necessary.



Hybrid, removable denture as the final restoration was selected. The Straumann® Novaloc® Retentive System for hybrid dentures offers an innovative carbon-based abutment coating with an excellent wear resistance.



Together with its durable PEEK matrices, the Novaloc® Retentive System provides a unique and long-lasting attachment performance. Straight and angled abutments (15°) are available with retention inserts force varying from 300g to 2550g.



Novaloc® abutments in place. The Mounting Collar blocks out the area surrounding the abutment, preventing that resin or a bonding agent flows into the Matrix Housing and embedding the abutment.



Titanium Matrix Housings with Mounting Collars prepared for fixation.



The prosthesis base with the prepared place for seating Novaloc® matrix housings. In the case of a prosthesis with a narrow base, it is necessary to make a metal reinforcement.



Relining with a silicone material to evaluate early contact points of the housings with the prosthesis. The denture should fit passively.



The Novaloc® housings can be fixed in the denture with acrylic materials.



Material Ufi Gel hard placed in the denture.



After the polymerization in the patient's mouth, the prosthesis can be removed. It is recommended to use inserts with low retention in the first phase.



Four retention inserts with a holding force of approximately 750g each. With increasing comfort of use, it may be necessary to increase the retention force by replacing the inserts with a stronger one.



Final work in the patient's mouth.

The decision about the type of final restoration depends on many factors. The hybrid denture with Novaloc® retentive system is an economical solution as well as optimizing hygiene. In the presented case, the four-month period of use of temporary screw-retained bridge allowed the patient to check whether maintaining good hygiene is not a problem.



Case 4

Immediate implantation - bridge

Description :

Diagnosis: *Teeth mobility of the third degree in the anterior region of the maxilla due to the periodontal disease.*

Treatment plan: Immediate implantation, immediate non functional loading

Planing software: coDiagnostiX™ (Dental Wings)

Tools and Materials: guide for implantation, Straumann BLT Guided surgery set, Straumann BLX SLActive implants,

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Gdańsk / Poland

Dental Technology

Björn Roland MDT

Klein-Winternheim / Germany



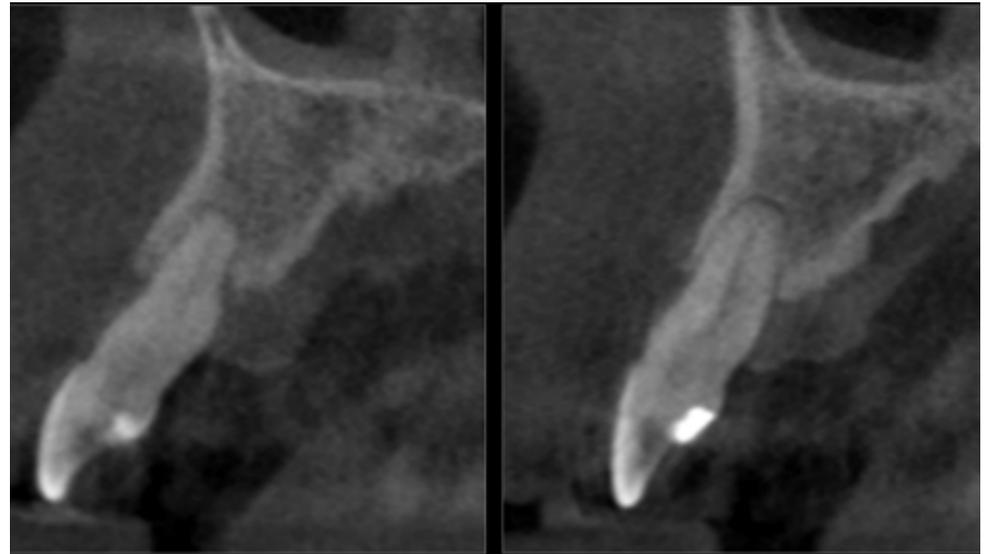
Initial situation in the mouth. Front teeth splinted with the composite. Non-stable situation and high mobility of the incisors related to the bone loss.



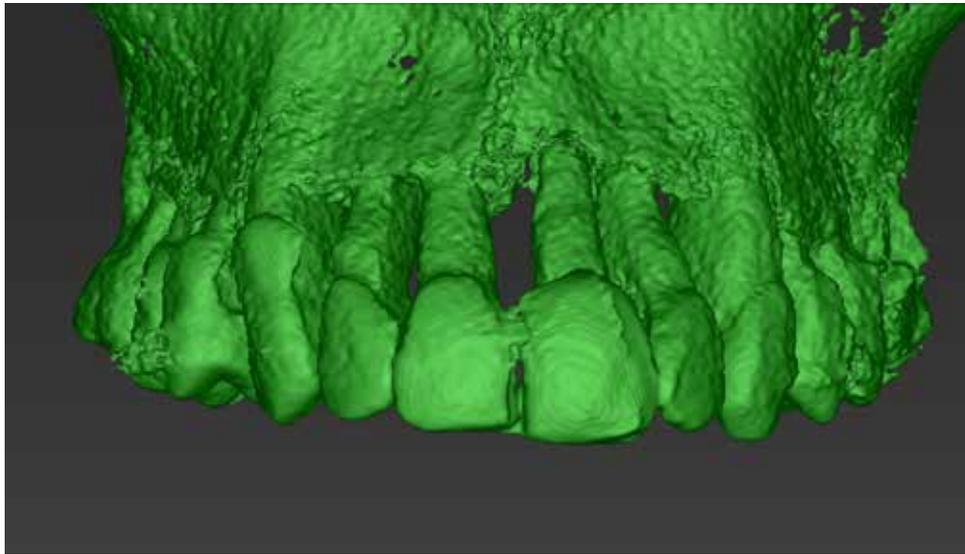
OPG x-ray representing the initial situation.



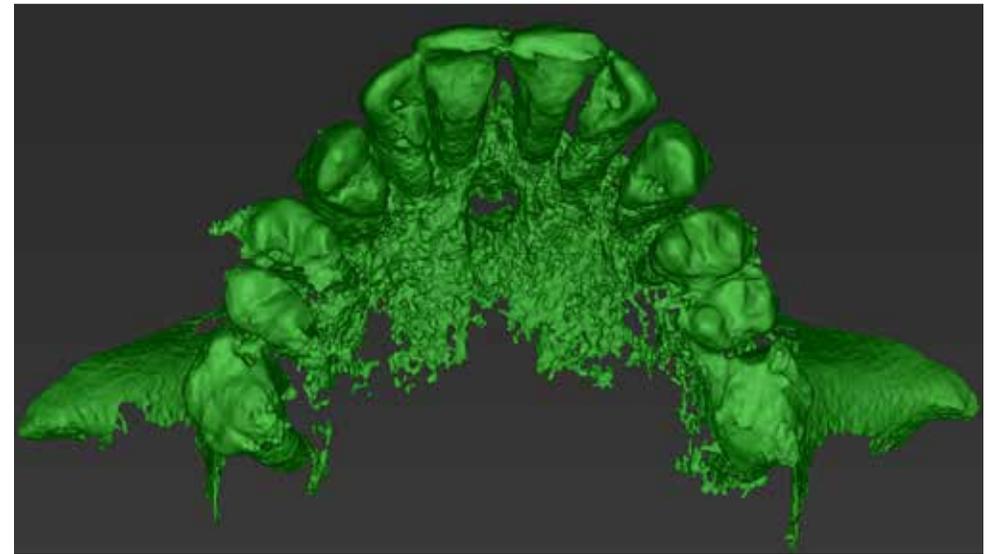
Loss of the soft tissue attachment and changed position is also visible from the palatal side.



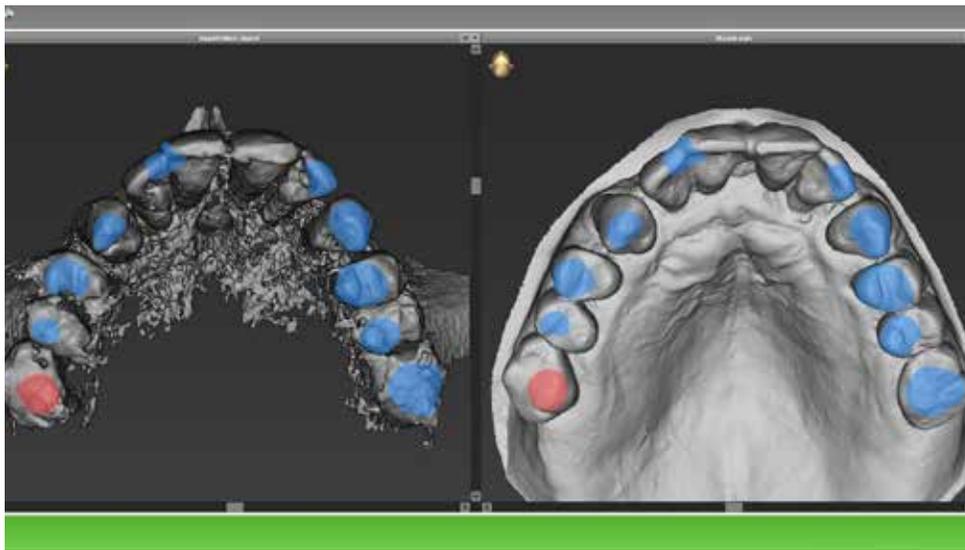
Cross-section through the long axis of the teeth.



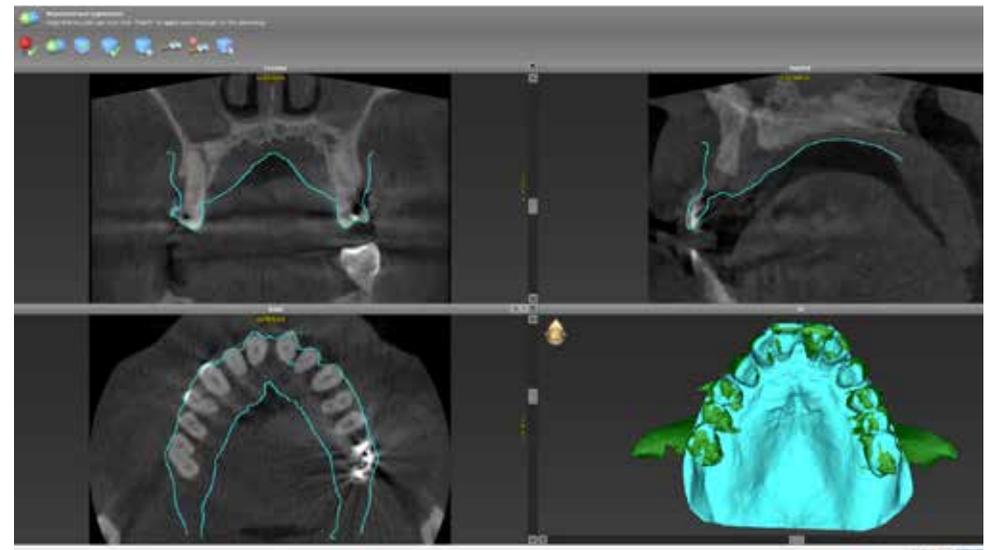
Segmentation of the upper jaw - front view.



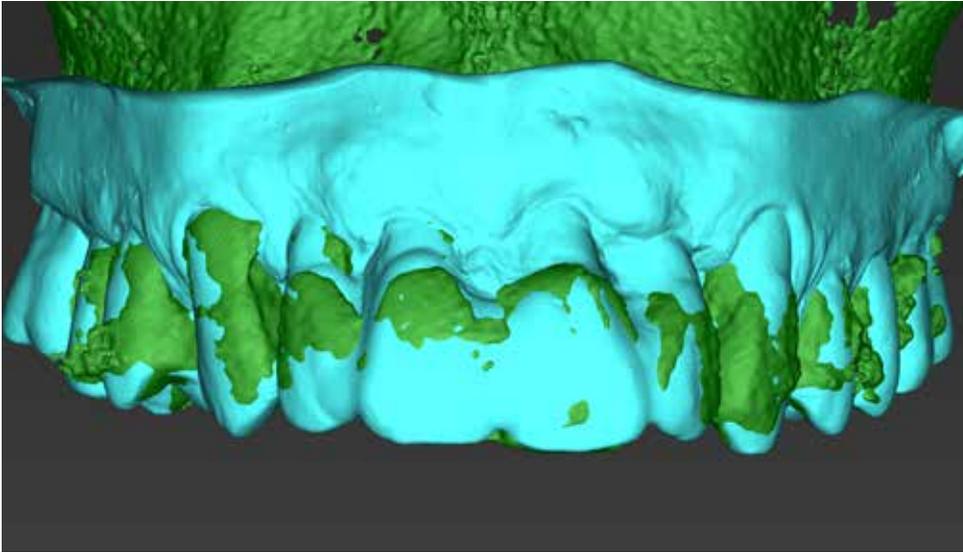
Segmentation for the upper jaw - occlusal view.



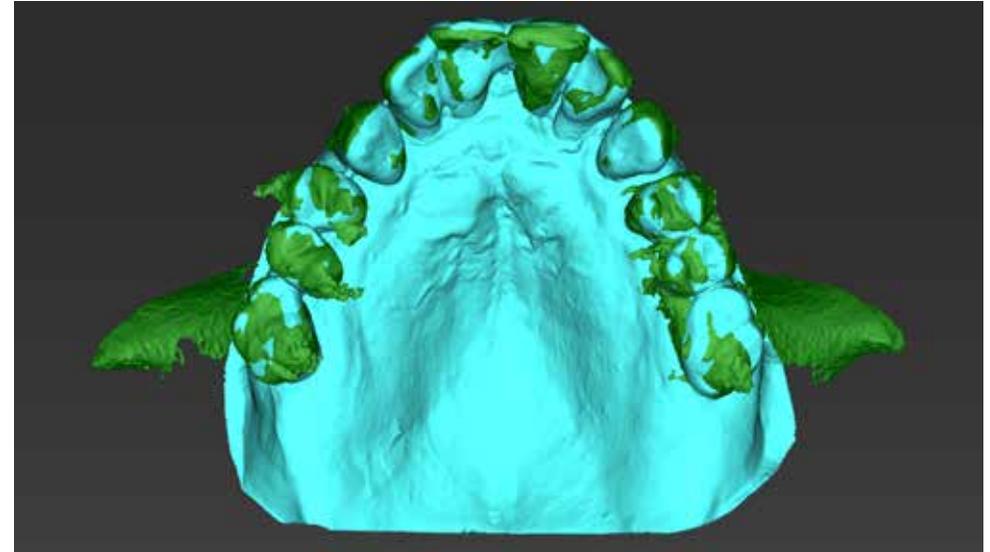
Process of matching data between DICOM and STL. The precision of integrity of the data is one of the essential element to reach the accuracy of guided surgery – mark at least three corresponding regions on both sets.



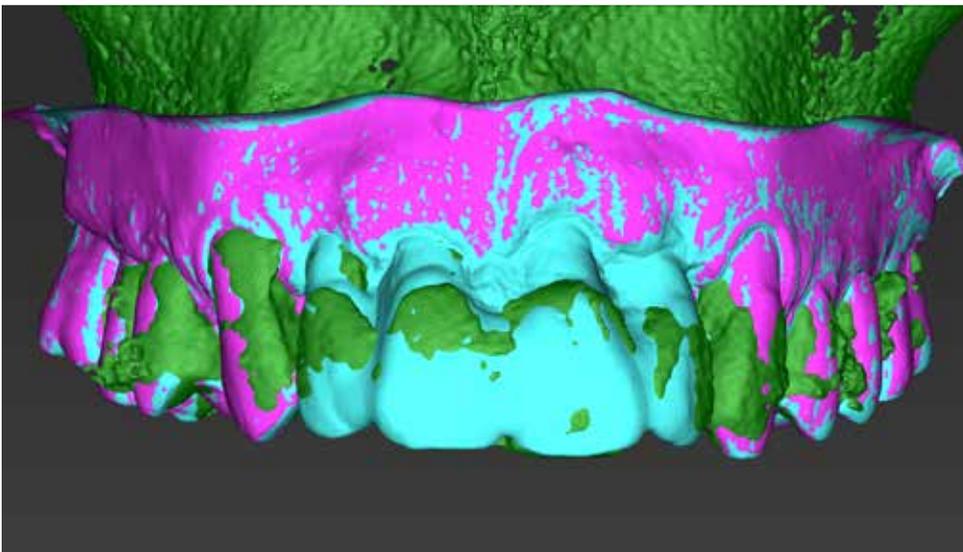
Alignment and registration. Different views in the cross section windows allow checking the precision of data.



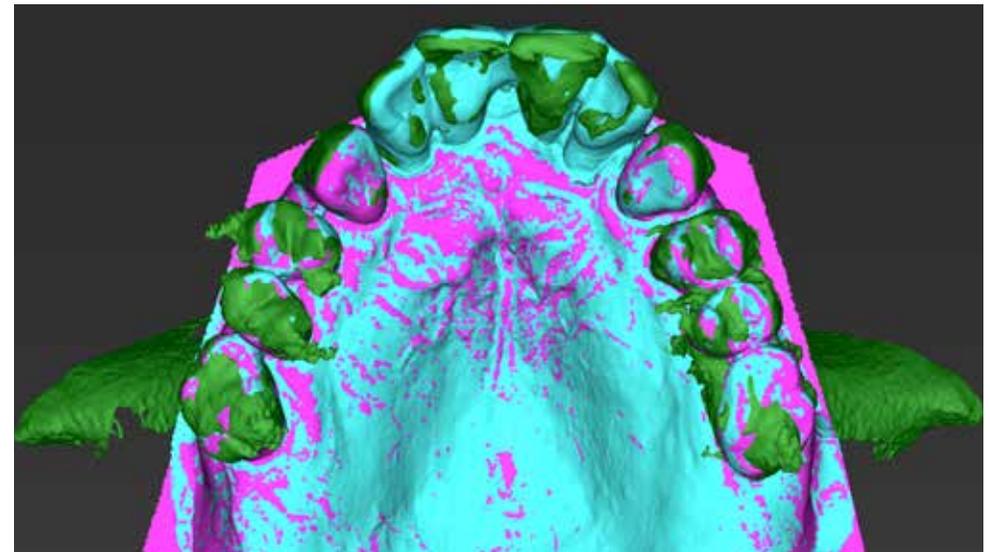
Aligned data from CBCT (DICOM - green) and scanner (STL - blue).



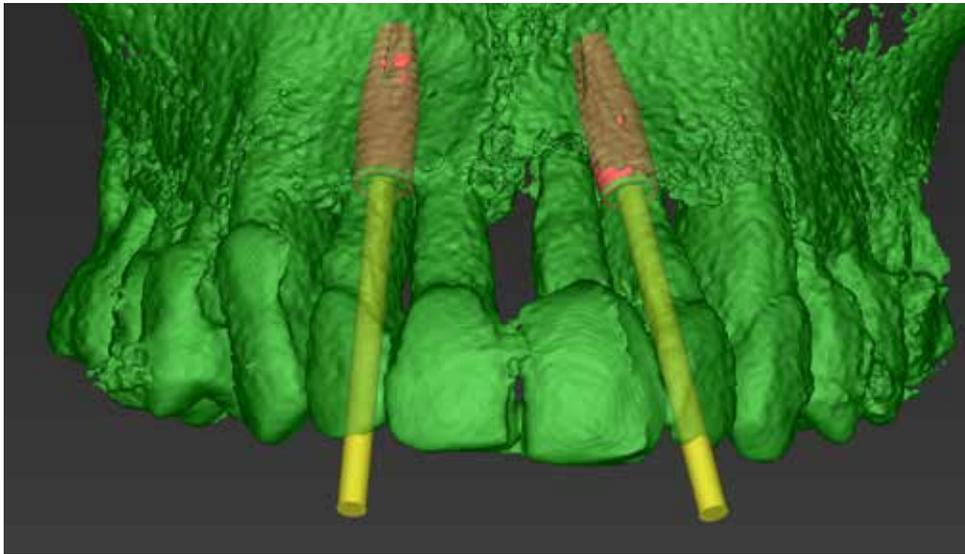
Artifacts from prosthetic restorations may make data integration difficult. Indication of common points between data is the basis for the correct implementation of this operation.



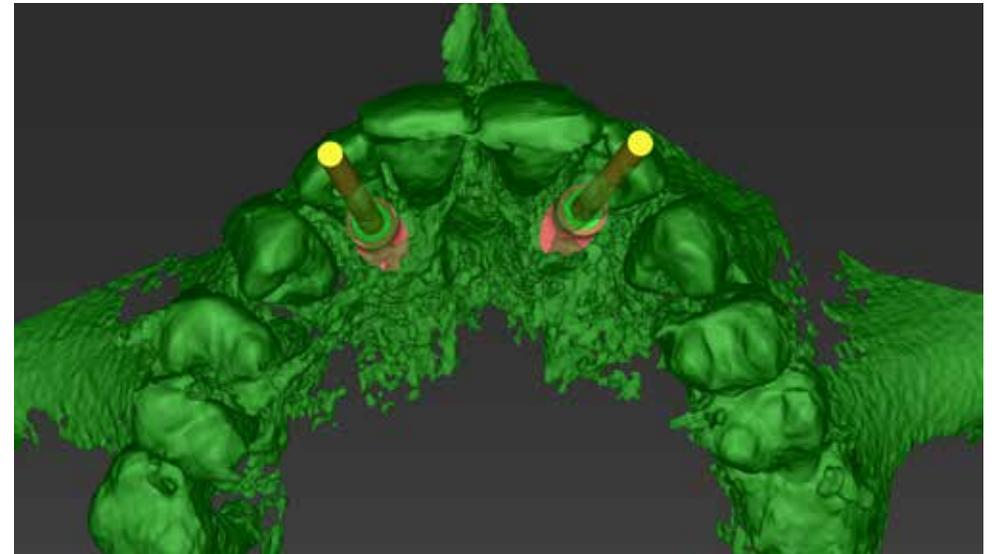
The coDiagnostiX® allows you to match multiple STL files. In this case, another model is added with the incisors removed (pink color).



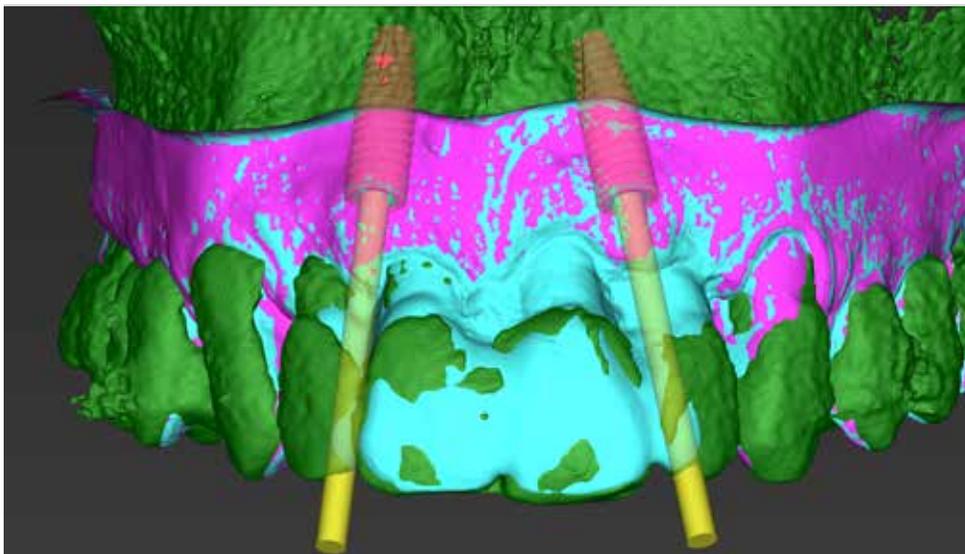
The picture illustrates integration between STL models differing only with the presence of incisors. The interpenetration of colors (blue and pink) is a desirable image.



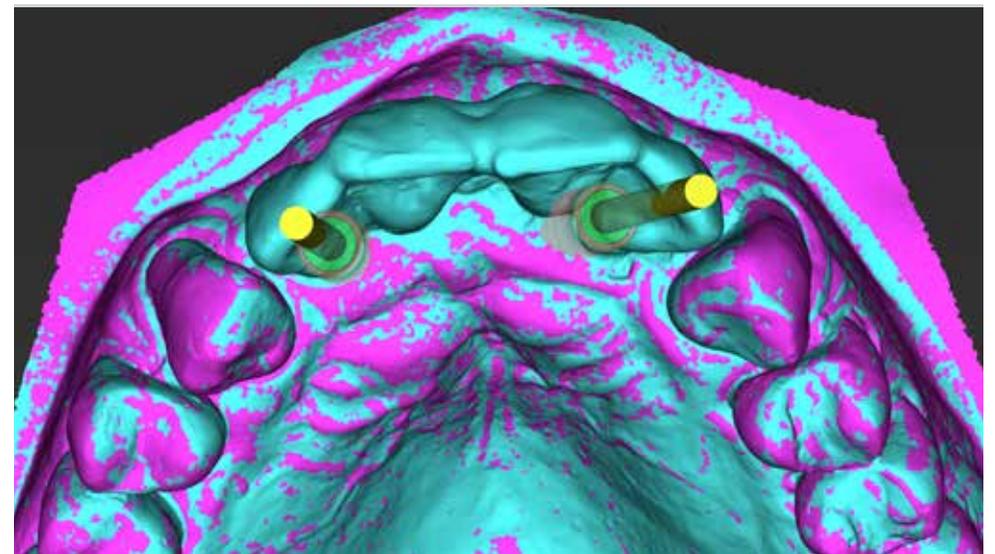
The positioning of the implants concerning the bone level and surrounding tissue - front view.



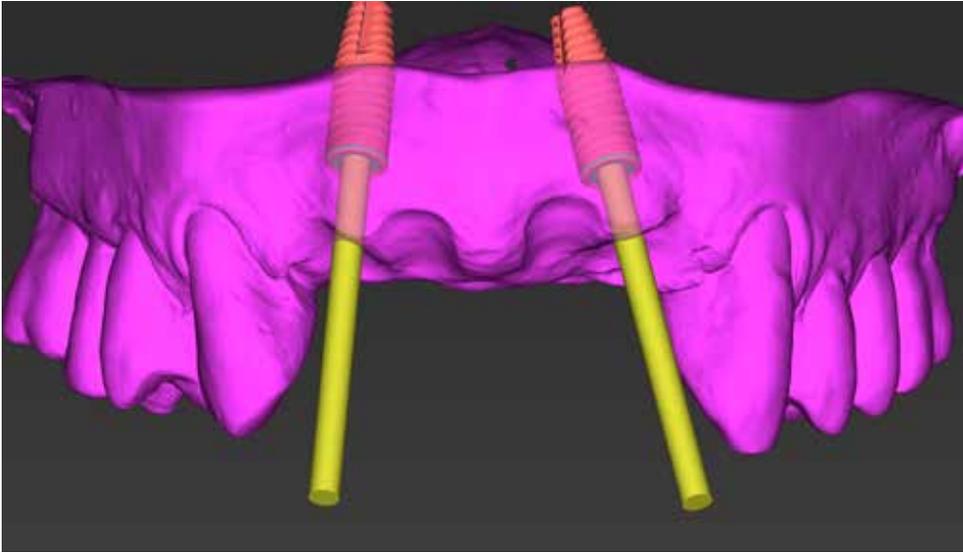
Planning of the vertical axis of the implants with a plan to deliver screw-retained restoration.



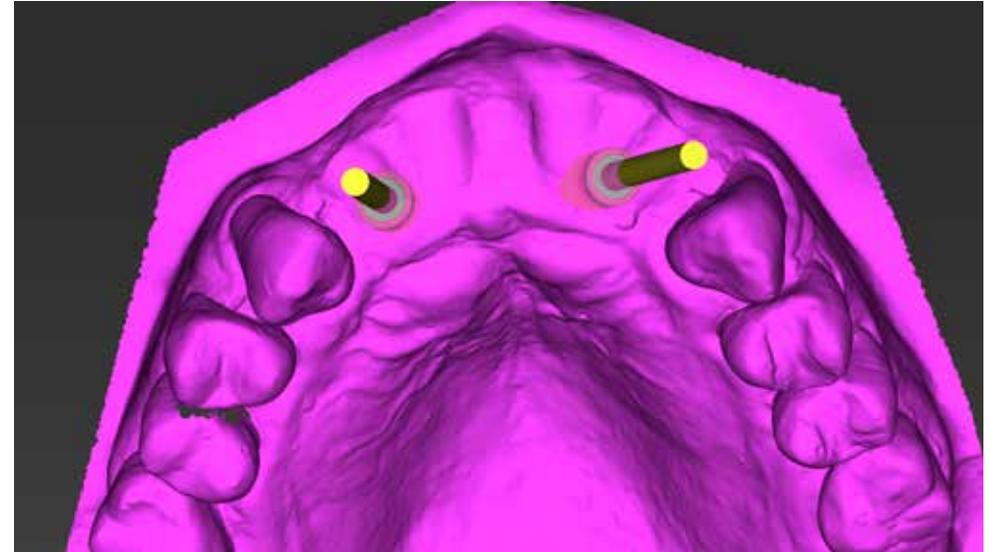
The positioning of the implants concerning the bone level and surrounding tissue - front view with applied information about the soft and hard tissue.



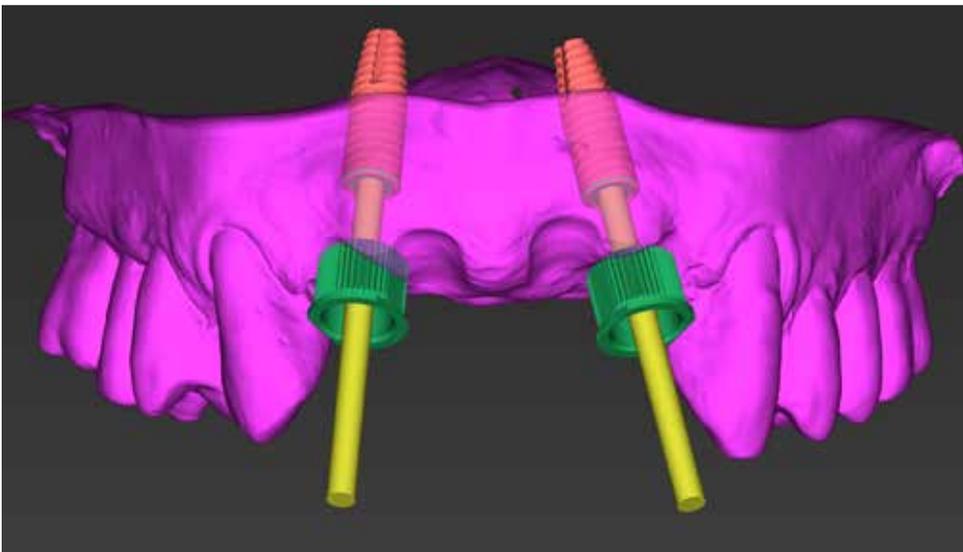
The position of the patient's teeth is a reference for the location of the implants and the temporary prosthetic restoration.



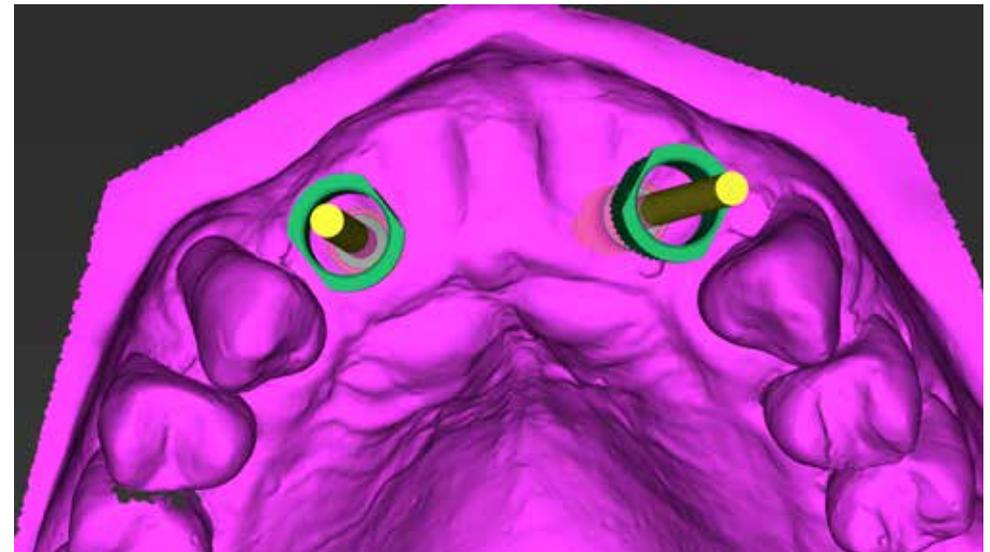
Continuation of planning with the STL model with teeth removed. Measurement tools help in assessing the thickness of the mucosa and the height of the future abutments.



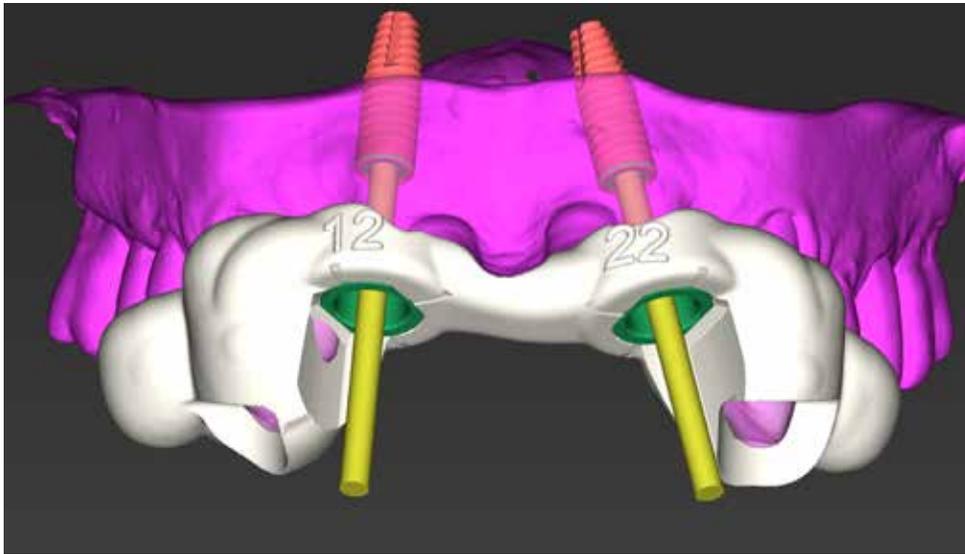
Occlusal view. The planned position allows for obtaining the desired volume of soft tissues for the aesthetics and stability of future restoration.



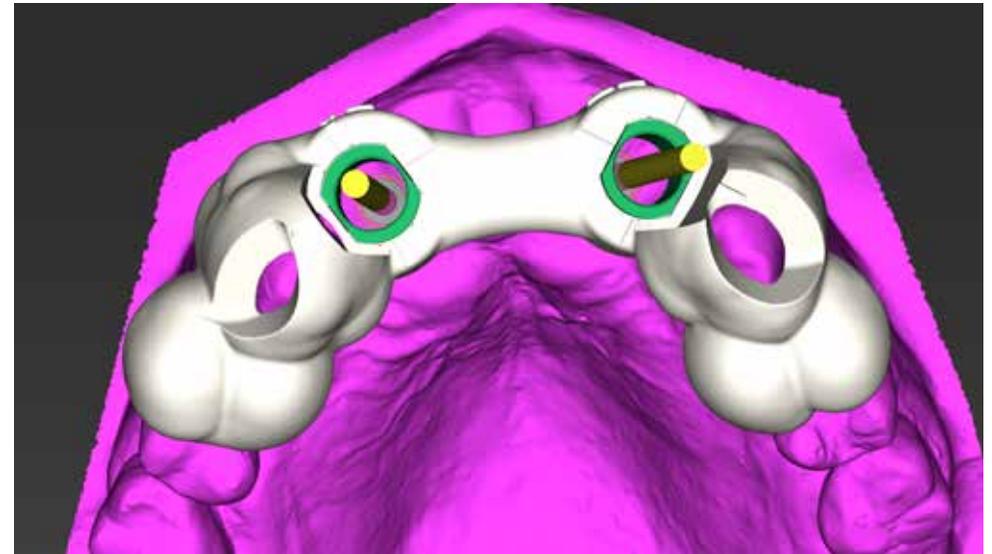
Planning the position of the sleeves. Distance from the sleeve to the implant is measured in the Straumann Guided surgery from the lower margin of the sleeve to the coronal part of the implant. Three positions are available H2, H4, and H6.



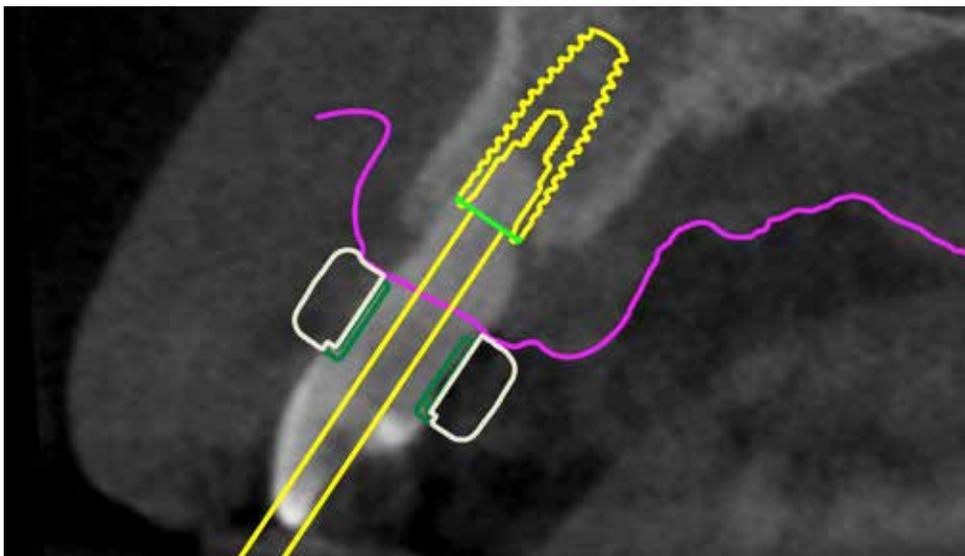
Sleeves for Straumann fully guided surgery for BLT implants are 5mm in the internal diameter. Distance in between the sleeve and the neighboring crown of the tooth needs to be saved for the guide material.



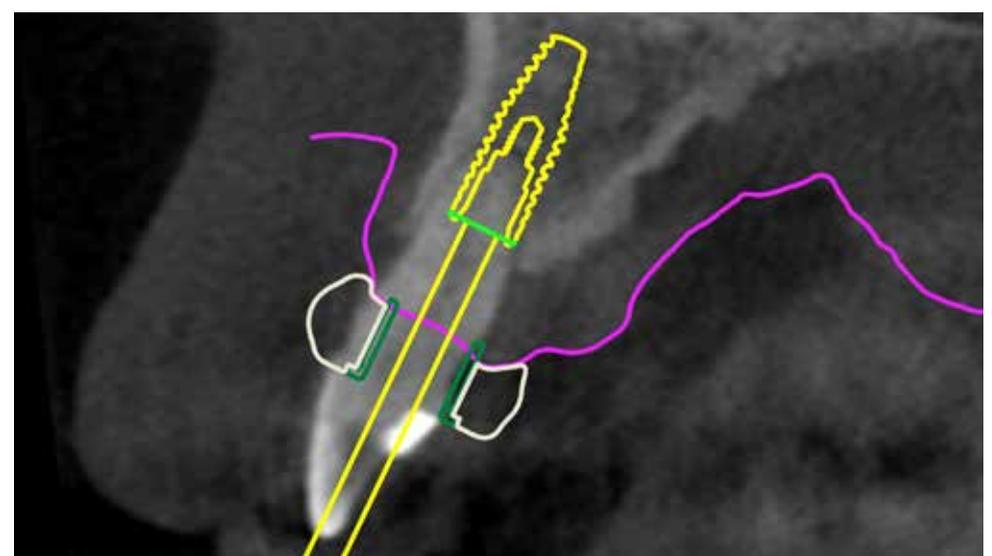
Design of the guide. Inspection windows are added in the mesial surfaces of the canines. It allows me to verify the passive fit but also leave more space for the handpiece with the drill.



If there is limited space in between the sleeve and the tooth, we prefer to select the "fit to form" geometry like in this case.



Cross section through the implant axis, showing also sleeves and guide in position 12.



Visible cross-section through the implant axis 22. Part of the sleeve, which is embedded in the soft tissue, will not be surrounded by the guide's material.



Extraction of the teeth with infiltration anesthesia.



Left central incisor with less than three mm bone support around the apical area of the root.



Lateral incisor with a visible zone of the remained periodontal attachment height.



Soft tissue architecture after extractions. If it's possible flapless procedure is preferred to keep the soft tissue level.



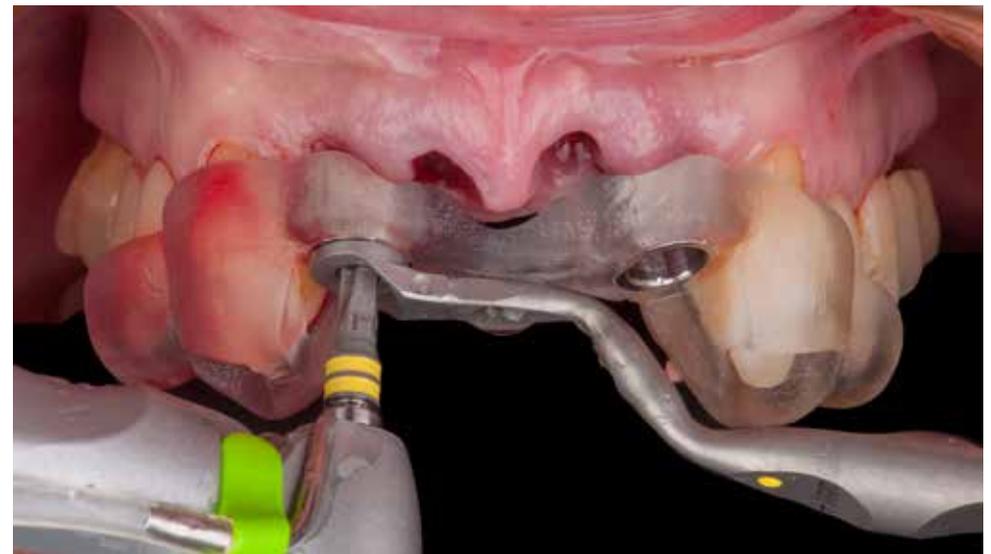
Trying the template for navigation in the mouth. Compared to the soft tissue scan before the surgery, the retraction of the soft tissue in the area of the central papilla is visible after teeth extraction.



Occlusal view. The guide fit is checked within inspection windows and also with general stability over the dentition.



Drilling sequence is performed according to the surgical plan for the BLT implant. Start with the pilot drill 2.2mm in the diameter. Drill handle collar is +1mm - also selected according to the surgical report from coDiagnostiX software.



Next drill in the sequence is 2.8mm in the diameter. Drill handle fits the selected drill.



Regular surgical tray for the Straumann BLX implant system is small and compact and it contains all the instruments for all the indications.



At the time of case preparation, there was no BLX guided surgery set available and final preparation and implant insertion was done with conventional instruments free hand.



BLX implant is fully tapered implant with the design dedicated to immediate solutions.



The implant size selected is Straumann BLX 4.5mm in diameter and 12mm long. Roxolid (TiZr) alloy is 20% stronger compared to the titanium alloys grade four.



BLX implant is delivered in the sterile package with SLActive surface. Packaging of the implant is different than usual. The implant is held in place with a basal pin. To retrieve the implant, a dedicated instrument is used as the implant holder.



Implant removed from the packaging before entering the mouth. The SLActive surface accelerates the deposition of active cells on the implant surface.



Placement of the implant from a free hand is done by machine driven instruments. It is necessary to control the axis of the implant by the operator. In the position of the missing tooth, the implant reached the torque over 60Ncm.



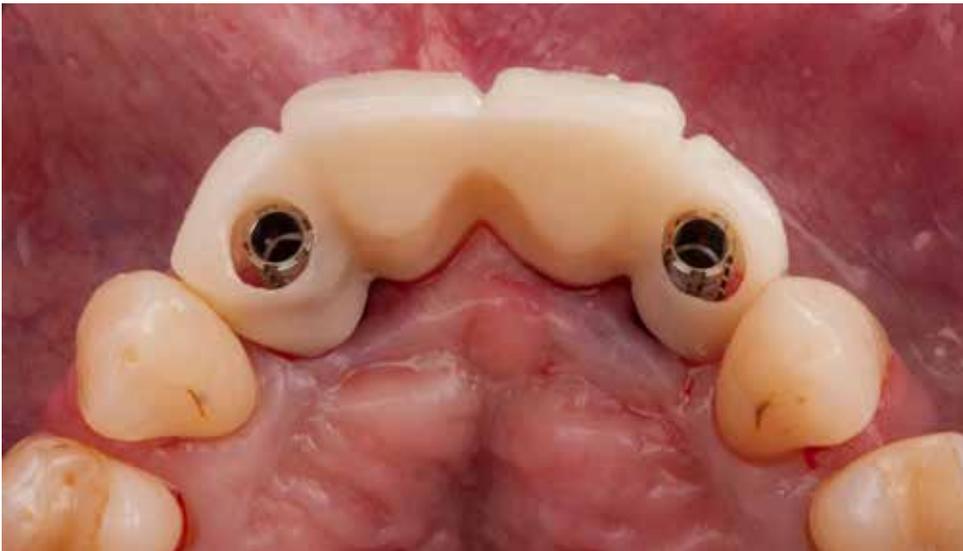
Second implant during placement. BLX implant length fits the preparation made with a BLT drill. Thanks to active thread design implant smoothly penetrate into the bone. The torque reached >60Ncm.



For the immediate temporary restoration two temporary abutments were selected.



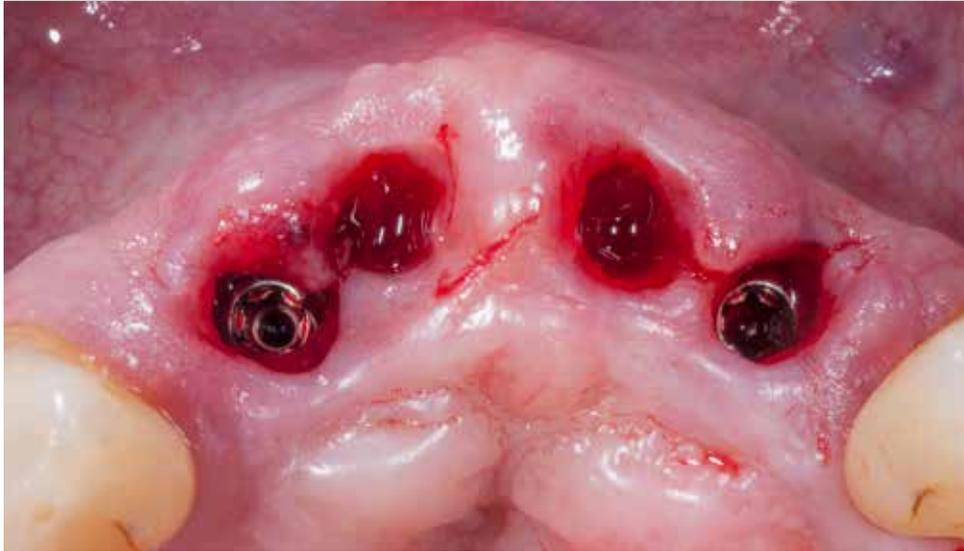
Position of the temporary abutments in the front view. In case of more significant divergence of the implant I will prefer to select angled screw-retained abutments and achieve desirable axis for the temporary sleeves.



As the temporary bridge, the laboratory technician prepared the "Shell" type bridge made of PMMA (shade A2). The shape is a copy from the initial scan of the situation in the mouth before the surgery.



Titanium sleeves we are sealing with the Teflon tape before connecting the materials. Fixing of the PMMA and sleeves, we did with flowable composite.



Situation visible after the bridge is removed. Position of the implants is in the perfect location for bone and soft tissue stability.



Augmentation of the postextraction sockets with small particles of xenograft material (Cerabone®, Botiss biomaterials).



I am sealing the sockets with two layers of the collagen sponge (Diacoll collagen fleece - Botiss biomaterials) to cover the biomaterial and stabilize the clot.



The temporary bridge ready for placement after finishing. Two "ovate pontics" will help to seal the sockets and keep the soft tissue architecture.



Placing a temporary bridge. The strength with which the bridge is screwed depends on the torque obtained at the stage of implant placement. In this case, the torque was 35Ncm.



Checking the contact points with the articulating paper 200 microns (Bausch/Germany).



Occlusal view with no marking points in the bridge after the adjustment. The access to the screws is sealed with Teflon tape and flowable composite.



The situation in the mouth immediately after the surgery. Shape and color of the temporary bridge help to keep the harmony of the smile.



Color transfer to the laboratory with photographs. Cross polarized reflected technique is used with the polar_eye® filter (emulation.me).



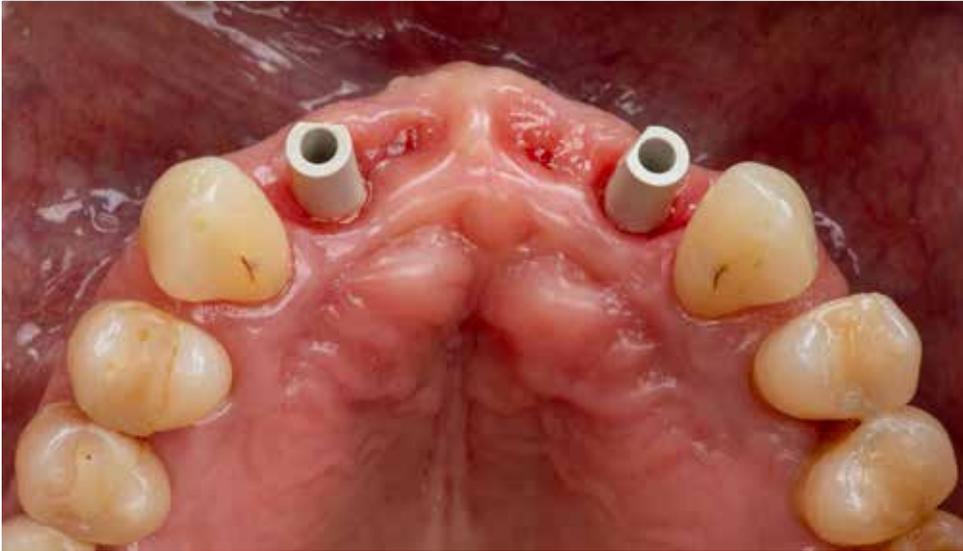
The lower dentition is photographed as well in the same technique to send reliable information about the color.



Digital impression technique is possible with BLX implants. Dedicated scanbody is selected (Straumann CARES® RB / WB Mono Scanbody).



Mount the Mono Scanbody with the screw to the implant. Use the Straumann® SCS Screwdriver for this step. Check for proper fit and for any rotational or vertical looseness of the scanbody in the implant. Hand-tighten the screw.



Avoid any contact of the Mono Scanbody to the approximal teeth. The Mono Scanbody is now ready for scanning.



Scanning the position of the implants with the intraoral scanner (Trios® 3Shape/Denmark).



Mesio structure prepared with Scan&Shape service in Germany. The printed model is equipped with digital lab analogs for the BLX implants.



Printed models in the position based on the bite registration with the intraoral scanner.



Front view of the mesio structure before ceramic layering.



Final restoration before connecting with the abutments.



Straumann original components: RB/WB Variobase® for Bar/Bridge abutments.



The Cementation Aid is specifically developed for the Variobase® for Bridge/Bar Cylindrical. It supports a fast and simple cementation procedure.



Insert dedicated Cementation Aid into each screw channel until it "clicks."



Cross-section through the Variobase abutment sealed with Cementation Aid to protect the screw channel.



Cementation step. Apply self-adhesive or dual cure dental cement through access hole.



Stop application of the cement when excess cement emerges from the abutment base.



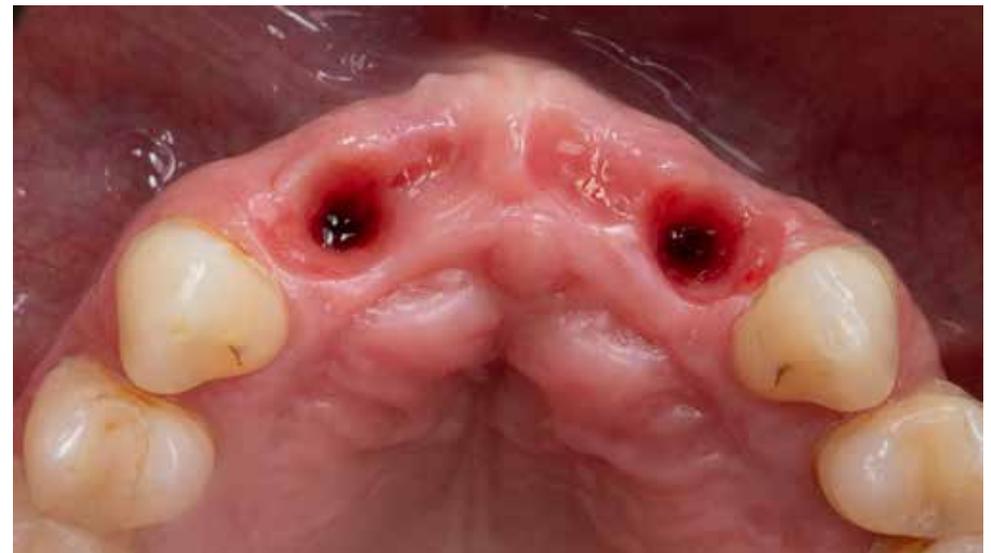
Finished bridge after curing and final polishing of the base after cementation.



Close-up of the RB/WB Variobase® for Bar/Bridge abutments after cementation in the restoration.



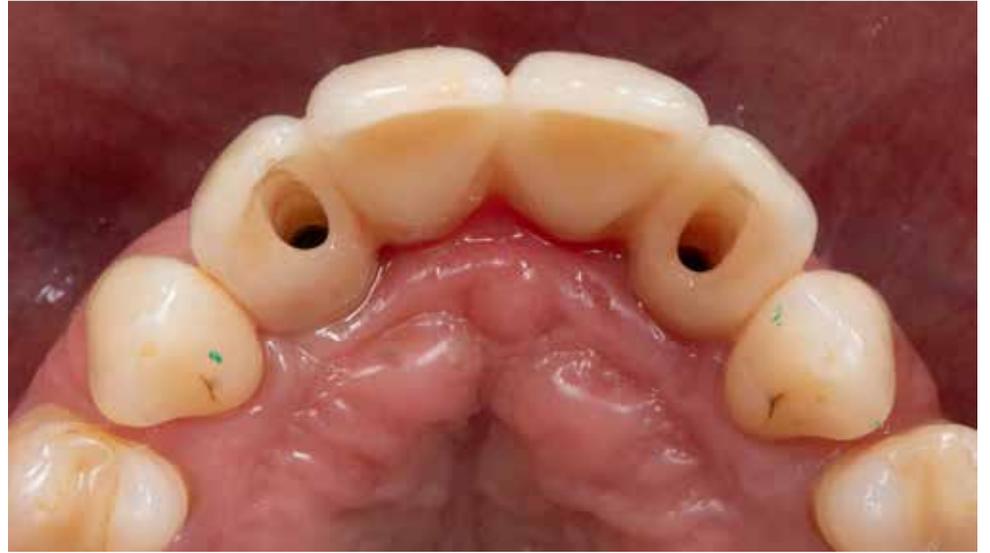
Healed situation four months after surgery. The architecture of the soft tissue is preserved with emergence profiles for crowns and pontics.



Soft tissue healing represents healthy status.



Delivery of the final restoration.



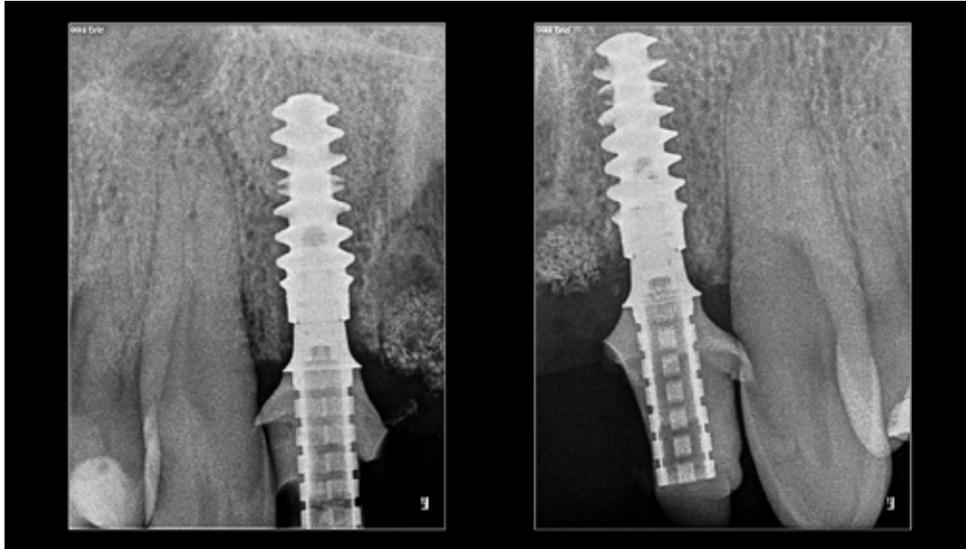
Access holes to the fixing screws in the final restoration are in a perfect position according to the initial planning in the coDiagnostiX.



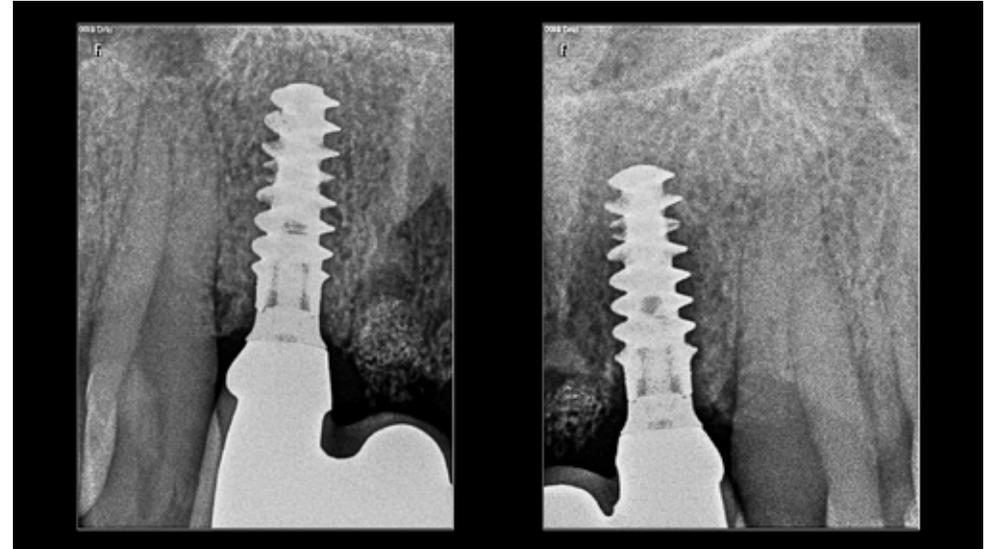
Integration to the soft tissue. Gentle soft tissue anemization on the day of delivery of prosthetic restoration.



The access holes were sealed with Teflon tape and flowable composite (G-aenial Universal Flo A1/GC)



X-ray control at the time of implantation.

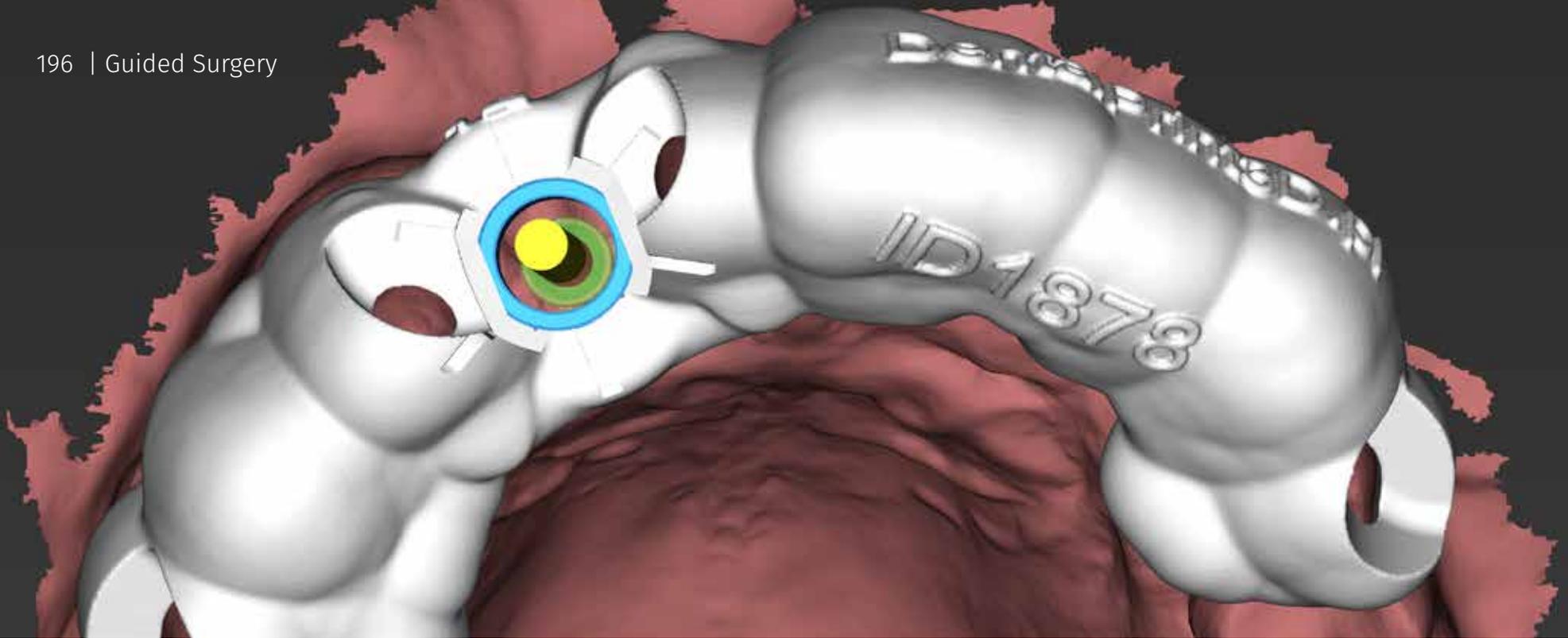


X-ray control 4 months later after the final bridge delivery.



Final bridge in the full smile display.





Case 5

Late implantation - lateral incisor

Planning, Surgery and Prosthetics

Maja Chmielewska, DDS
Gdańsk / Poland

Dental Technology

SmileClinic LAB
Gdańsk / Poland

Description :

Diagnosis: *Situation six months after implant loss due to the lack of integration*

Treatment plan: Late implantation, open healing

Planing software: coDiagnostiX™ (Dental Wings)

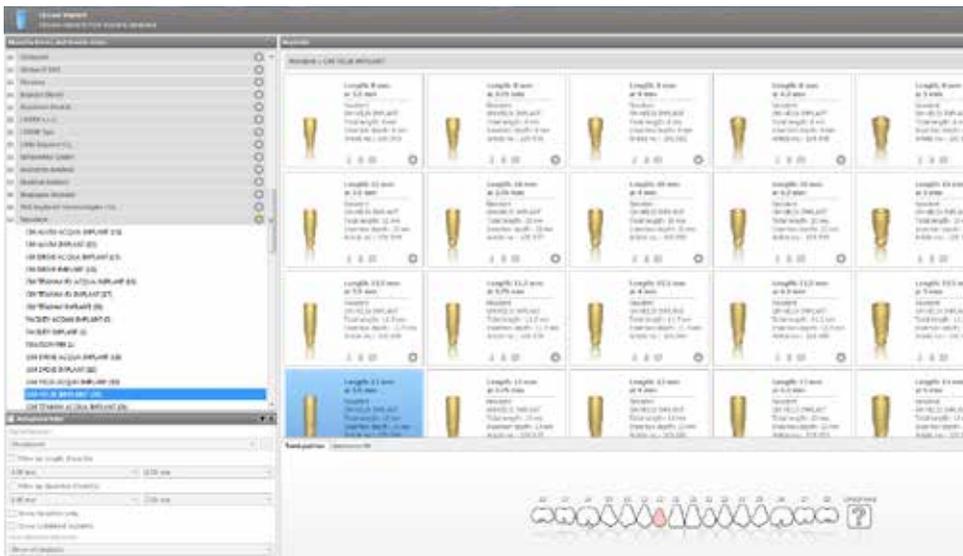
Tools and Materials: guide for implantation, Neodent GM Guided surgery set, Neodent GM Helix Aqua implant,



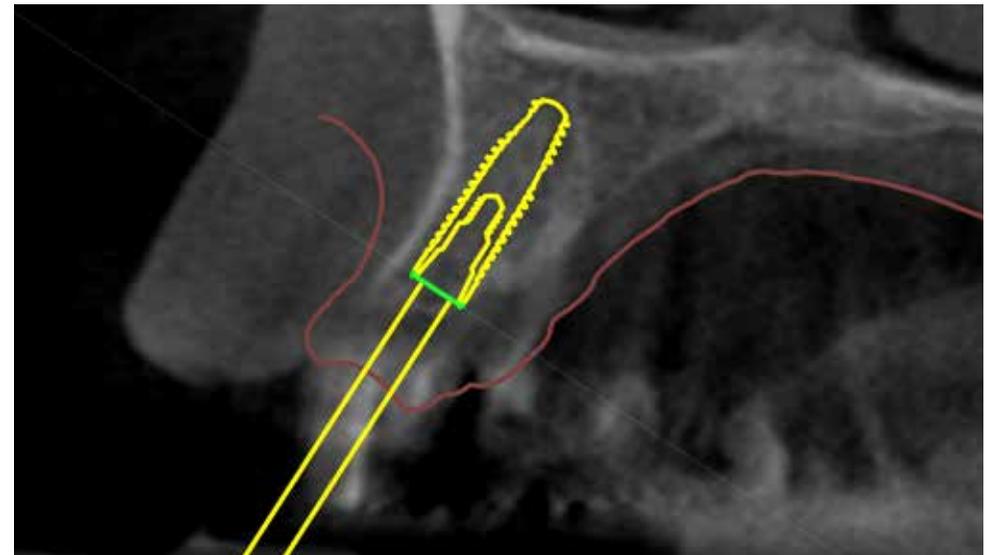
Initial situation. Temporary bridge in place in the position of the missing upper right lateral incisor.



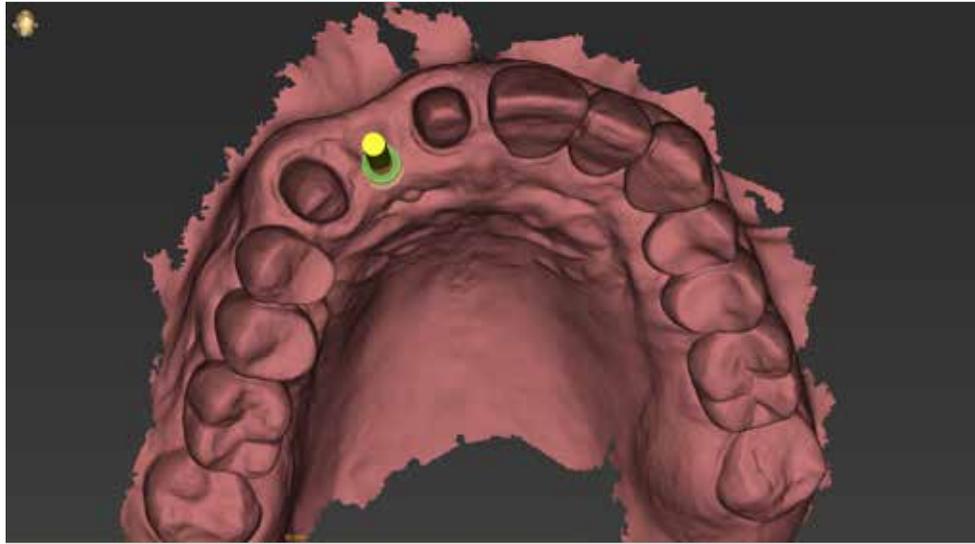
Situation after removal of the temporary bridge.



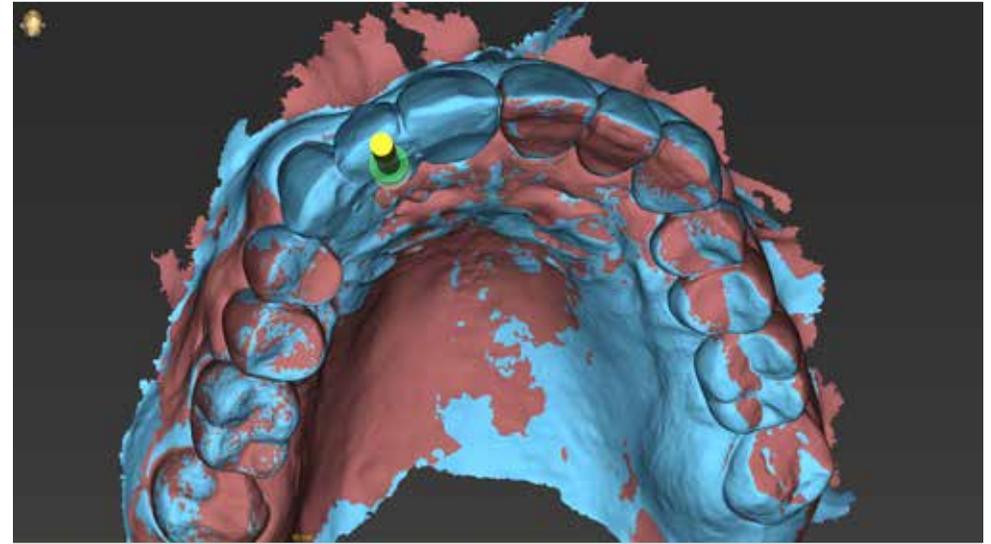
Selection of the implant from the coDiagnostiX library - implant type and size: Neodent GM Helix with length 13mm and diameter 3.5mm



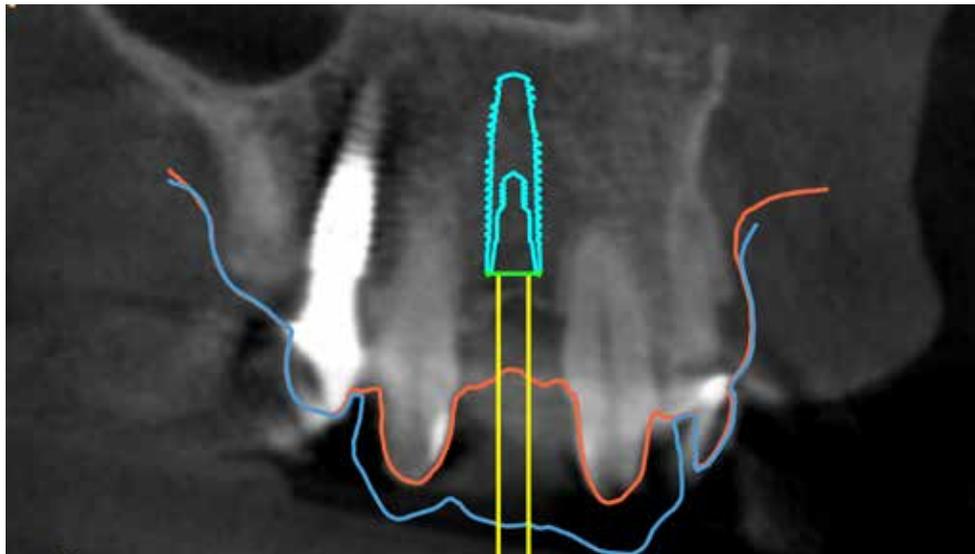
The planning process of the implant position. Brown line is an outline of the soft tissue acquired from the IO scanner.



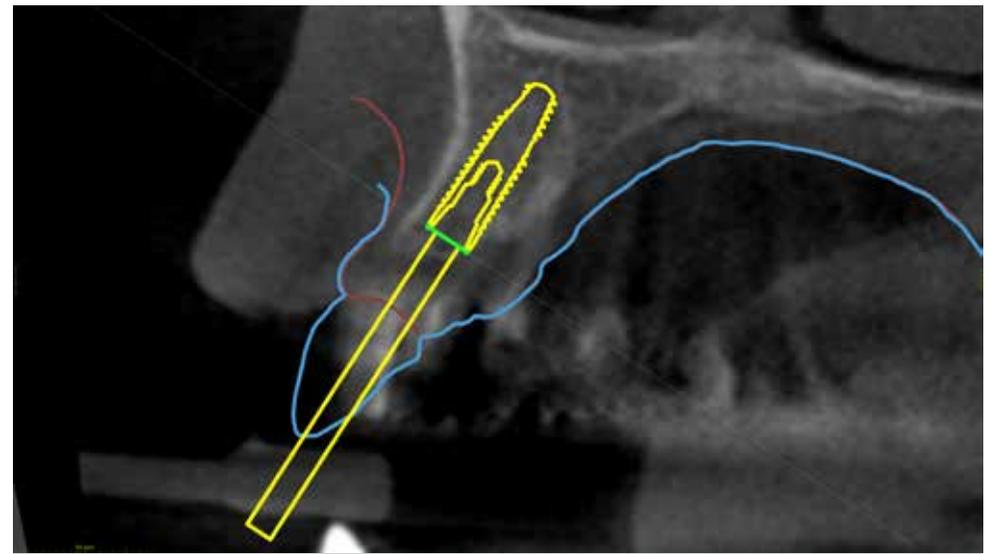
STL file generated with the intraoral (IO) scanner and implant position according to the initial planning.



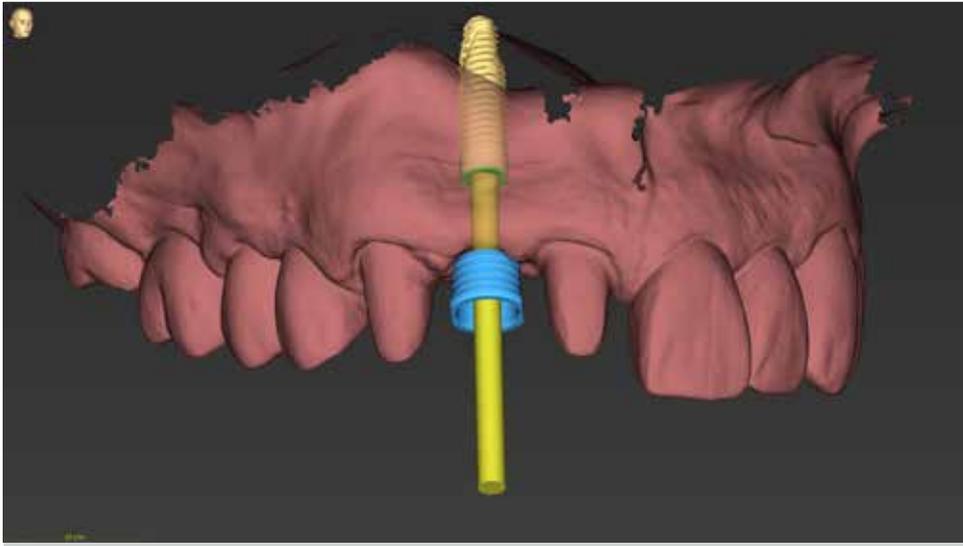
The coDiagnostiX software allows importing more than one STL file. It helps to superimpose the layers with the wax-up or prescan with a temporary restoration to visualize the future tooth position.



Tangential view - positioning of the implant with respect to the distance to the adjacent roots.



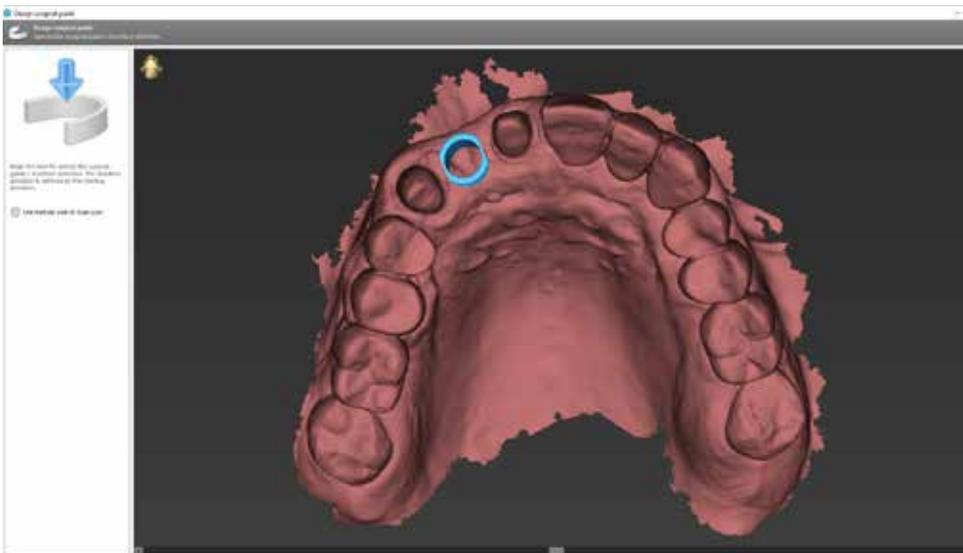
A cross-sectional view of the implant position to the soft tissue and the temporary crown position (blue outline).



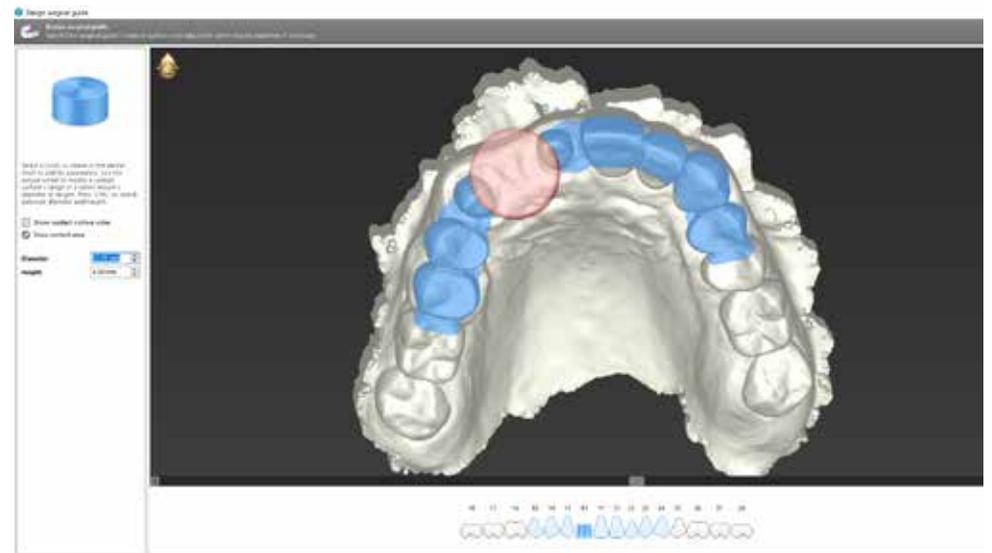
Selection of the Regular Guided Sleeve from the Neodent library in the coDiagnostiX software. The sleeve should be positioned above the soft tissue level.



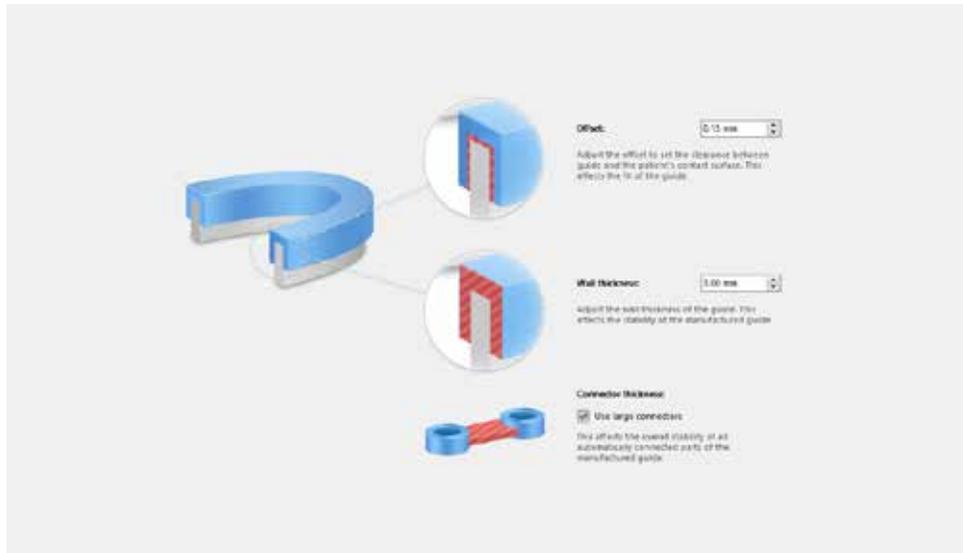
Cross-section with the position of the sleeve (blue) above the soft tissue (brown outline). The two sleeve positions are available: 5 mm (H9) or 7 mm (H11), considering 9 and 11 mm from the upper part of the sleeve to the implant platform.



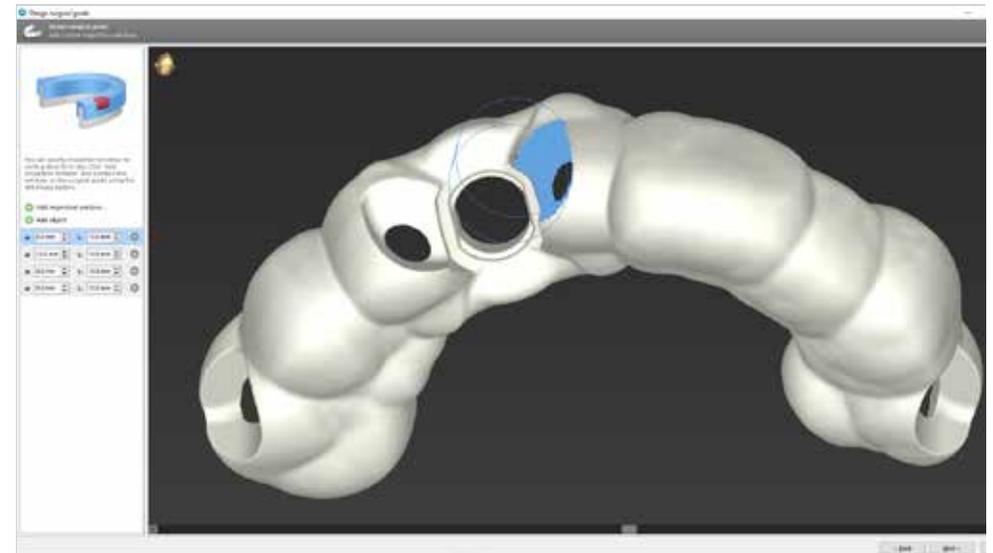
Design surgical guide: specifying a surgical guide's insertion direction.



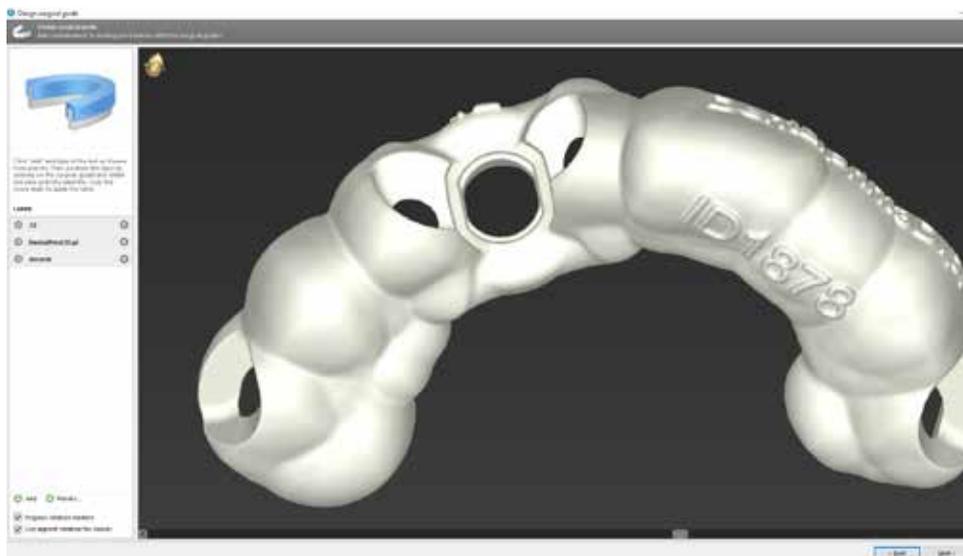
Design surgical guide: specify the surgical guides' contact surfaces and adjust the sleeve mount diameter if necessary.



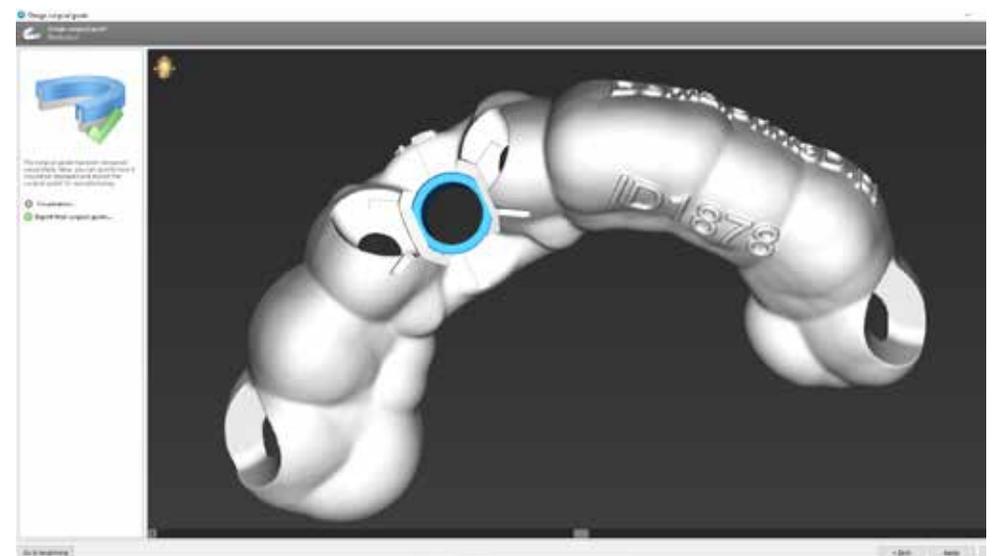
Design surgical guide: adjust surgical guide's wall thickness and its offset. Wall thickness of 3.0mm is selected to achieve the stability of the manufactured guide. The offset affects the fit of the guide.



Design surgical guide: add custom inspection windows. The size and position of each window can be adjusted individually.



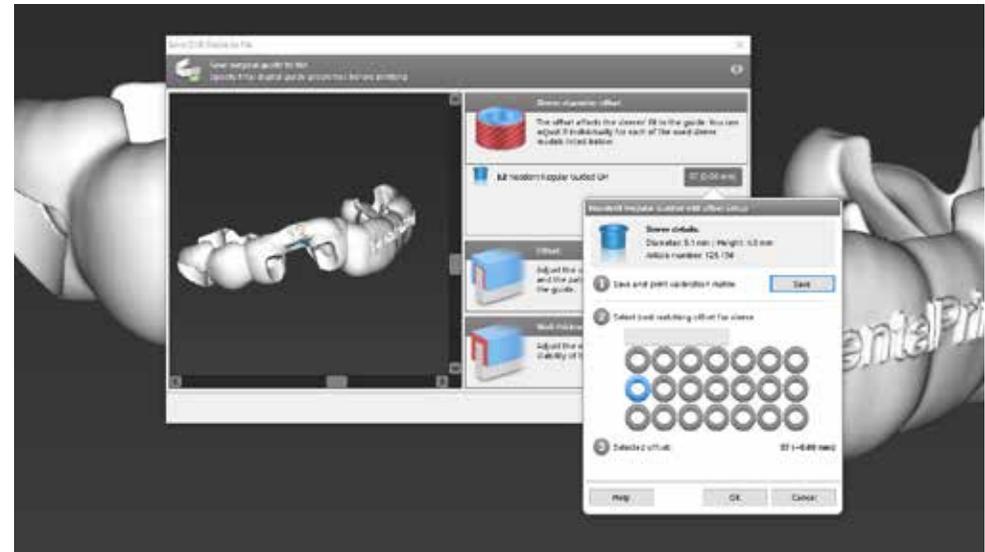
Design surgical guide: add custom labels to distinguish between different surgical guides.



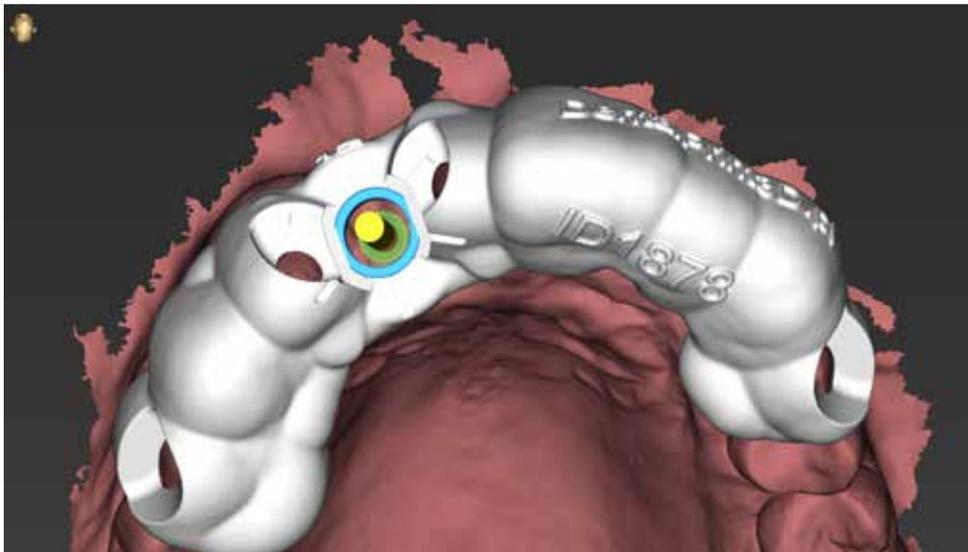
Design surgical guide: Finalization. At this step, you can specify how it should be displayed and export the surgical guide for manufacturing.



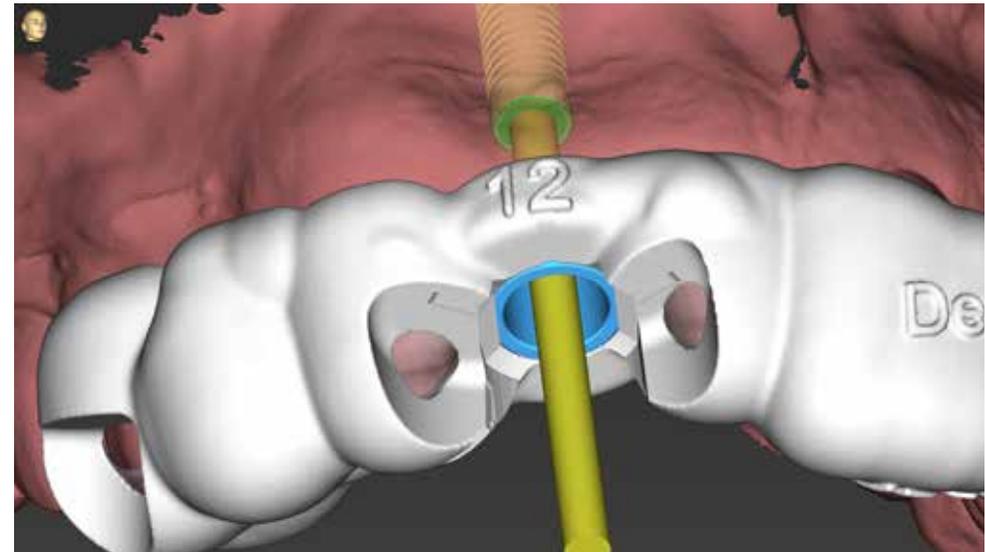
Export final surgical guide. Save surgical guide to the STL file. At this step, verify and specify final digital guide properties like offsets and wall thickness before printing.



IMPORTANT: Select best matching offset for a sleeve with a calibration matrix. The sleeve diameter offset depends on the printer individually. You must save and print calibration matrix at first to know which offset to select.



Surgical guide applied to the project. Inspection windows and labeling are visible.



Inspection windows next to the sleeve position help to determine the fit of the surgical guide and easily insert the instruments and handpiece.



STL file of the surgical guide generated with coDiagnostiX for manufacturing.



Surgical guide printed with Stratasys Objet 260 Dental Selection printer. The sleeve fits perfectly with press-fit to the calibrated geometry in the printed guide.



Surgical guide in place - intraoral verification of the printed guide. The teeth visible in all inspection windows should be in contact with the guide's material.



Stability of the surgical guide depends on the wall thickness and design. Extended size of the guide to the premolars helps to keep the guide in place and give access to keep it in place with fingers.



A printed guide with engraved rotation markers. Black lacquer was used to distinguish the position of the marker clearly.



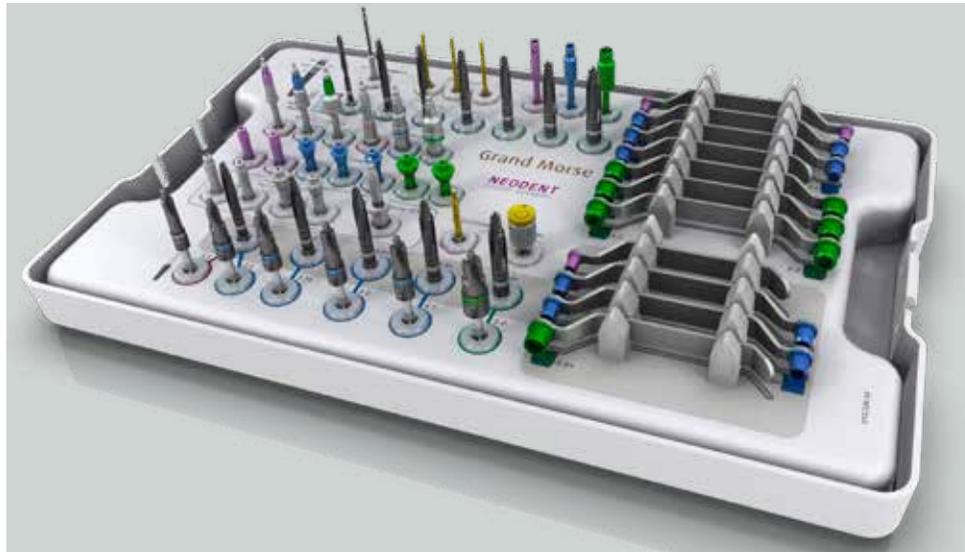
The punch (mucosa extractor) is an optional surgical instrument with a contra-angle fitting on one edge and a cutting cylindrical format on the other. Its indication is for circular incision in the mucosa before bone bed preparation.



The punch is color-coded according to the diameter of the sleeve. Contact to the bone limits the insertion depth of the instrument. The indicated speed (rpm) for drilling is 60 rpm.



Removal of the remaining soft tissue ring, which was attached to the bone.



The Neodent® Guided Surgery Kit for Grand Morse™ is designed for all bone types. Color-coded sequences help for a reliable working process.



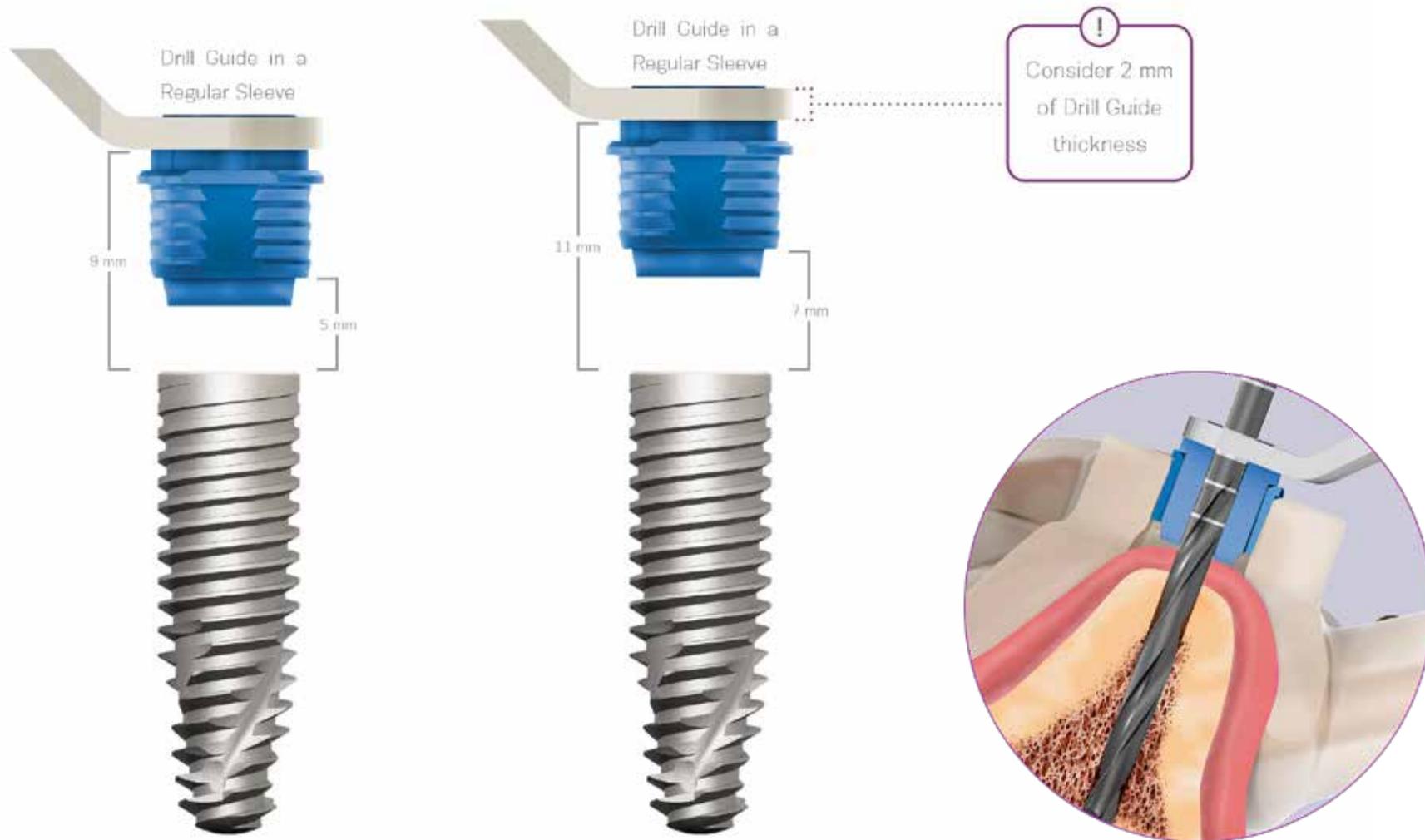
Tapered Guided Surgery Drills are indicated to prepare the osteotomy, following the sequence based on implant type and diameter, as chosen in the preoperative plan.



The drills have to be used together with the corresponding drill guides (handles) and sleeves fixed in the surgical guide. Rotation speed used for the drill is 800 rpm.



Drill diameter 3.5mm is used in the next step to finish the osteotomy. Depth lines on the drills are marked to ensure depth control. The drills are without physical stoppers and clinician needs to verify the drilling depth with the depth lines.



The GM NGS System allows selecting two sleeve positions - H9 and H11. The distance indicates 9 or 11 mm from the upper part of the sleeve to the implant platform. Neodent sleeve height is 4mm. The thickness of the soft tissue and the insertion depth of the implant determines the sleeve position and is calculated during planning in the coDiagnostiX software. It's essential to check the drill marks to sleeve position to obtain the proper depth of the osteotomy



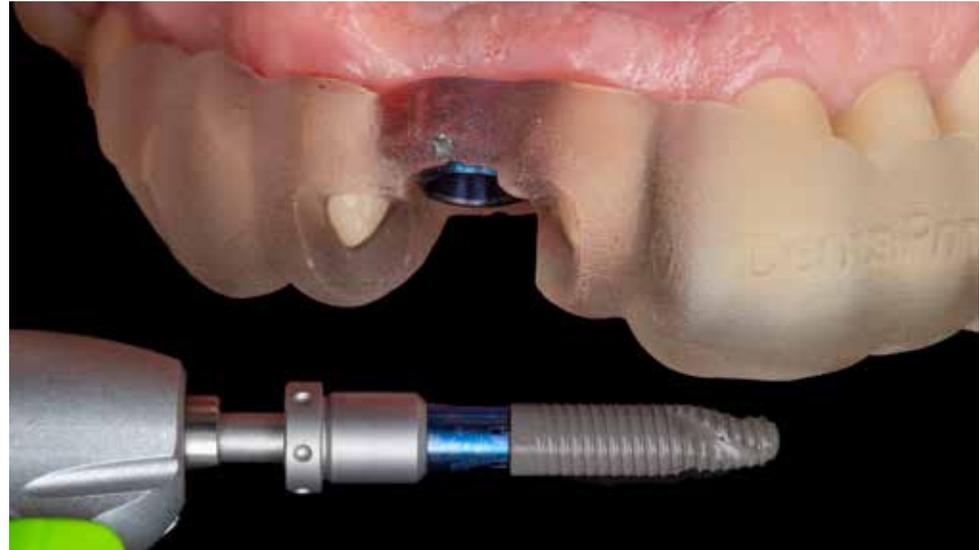
The Neodent® Acqua hydrophilic surface is the next level of the highly successful S.L.A. type of surface developed to achieve successful outcomes even in challenging situations, such as soft bone or immediate protocols.



The GM (Grand Morse) Helix Implant mounted in the package after removal from the liquid.



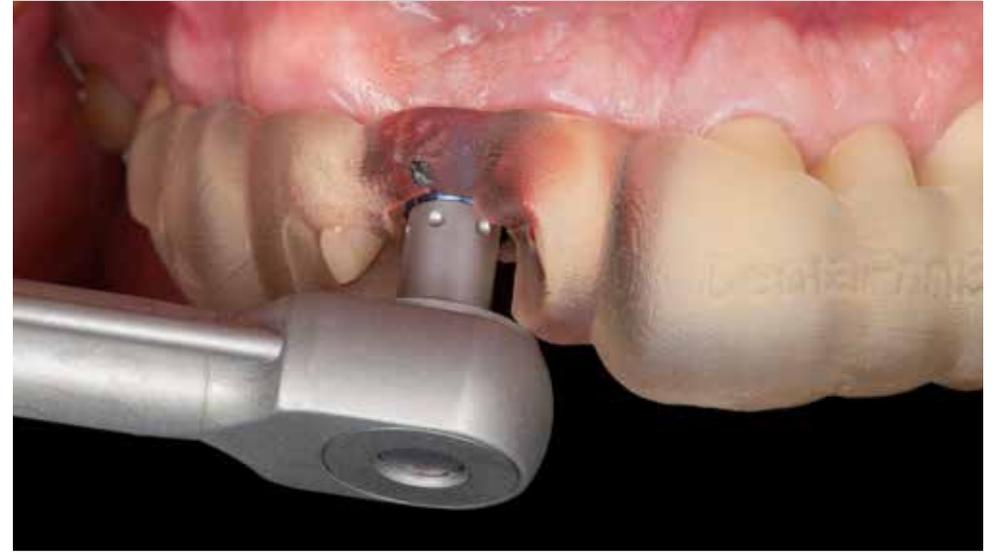
GM NGS Connection (insertion adapters) allows to capture the implant from the packaging for fully-guided insertion of GM Implant through color-coded GM NGS Sleeve and ensures the right positioning with physical depth control.



Neodent® GM implants were developed to begin placement with contra-angle or manually, and finished with the torque wrench. The maximum recommended rotation speed for implant installation is 30 rpm, with a torque of 32 N.cm.



The adapter allows subcrestal implant placement, due to the consistency of diameters between connection and implant. The dimples indicate the position of the internal connection.



Final implant positioning with the manual torque wrench. Alignment of one of the dimples with the index marker helps to reach the optimum position of the internal connection according to the plan and prosthetic rehabilitation.



GM Healing Abutment 5.5mm during installation. Chlorhexidine gel is applied.



Situation after implant insertion with the flapless protocol.



The Neodent® GM scanbody before placement. The Neodent scanbodies are made in PEEK, an opaque polymer that eliminates the need for any scanning spray.



The Neodent® GM scanbody in place. The scanbody is used on an implant to transfer its position following scanning for use in CAD/CAM procedure.

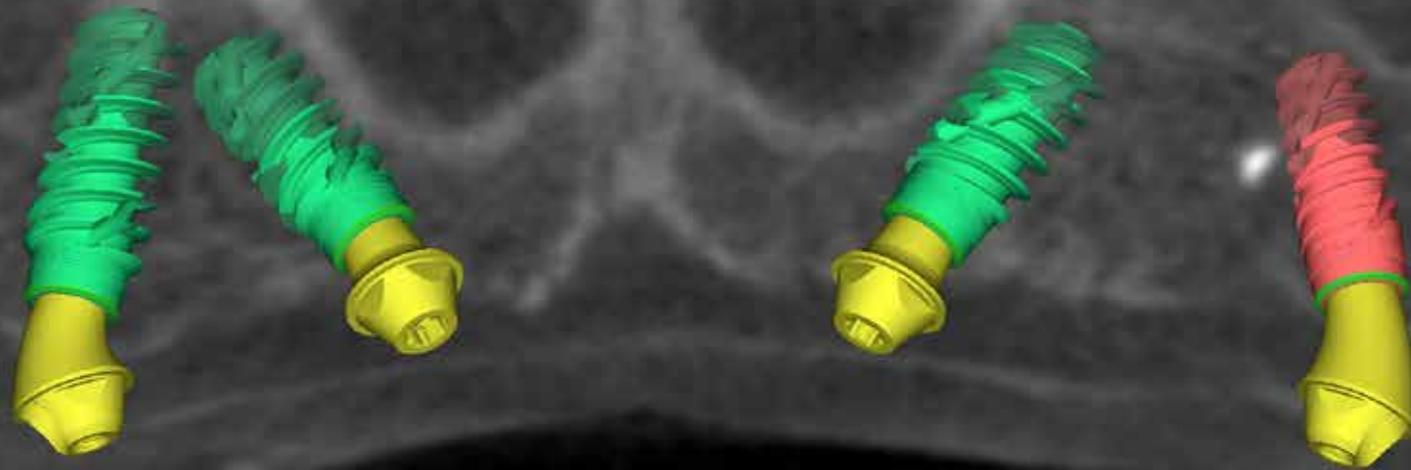


Temporary restorations made of PMMA.



Temporary screw-retained PMMA crown in place. For soft tissue maturation and establishing final emergence profile, it's essential to wait at least three months. Papilla level is affected by the bone level next to the central incisor.

The missing papilla is not visible in the smile thanks to the low lip dynamic.
The final restoration will be delivered after the soft tissue and papilla maturation.



Case 6

Edentulous maxilla

Description :

Diagnosis: *Edentulism. Situation five months after the terminal dentition was removed.*

Treatment plan: Immediate functional loading with 4 implants

Planing software: coDiagnostiX™ (Dental Wings)

Tools and Materials: guide for implantation, Straumann BLT surgery set, Straumann BLX implants

Planning, Surgery and Prosthetics

Kris Chmielewski, DDS, MSc

Maja Chmielewska, DDS

Gdańsk / Poland

Dental Technology

SmileClinic LAB / Dental Print 3D

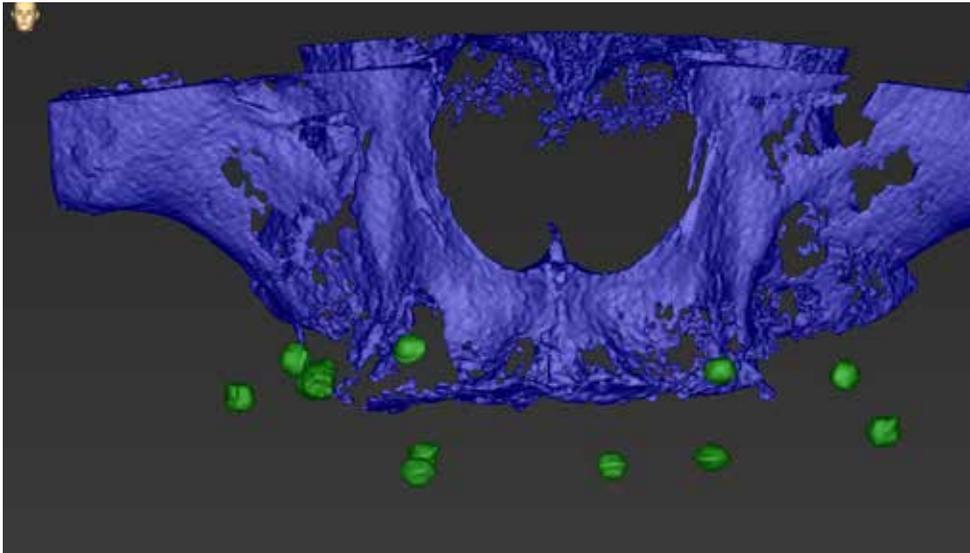
Gdańsk / Poland



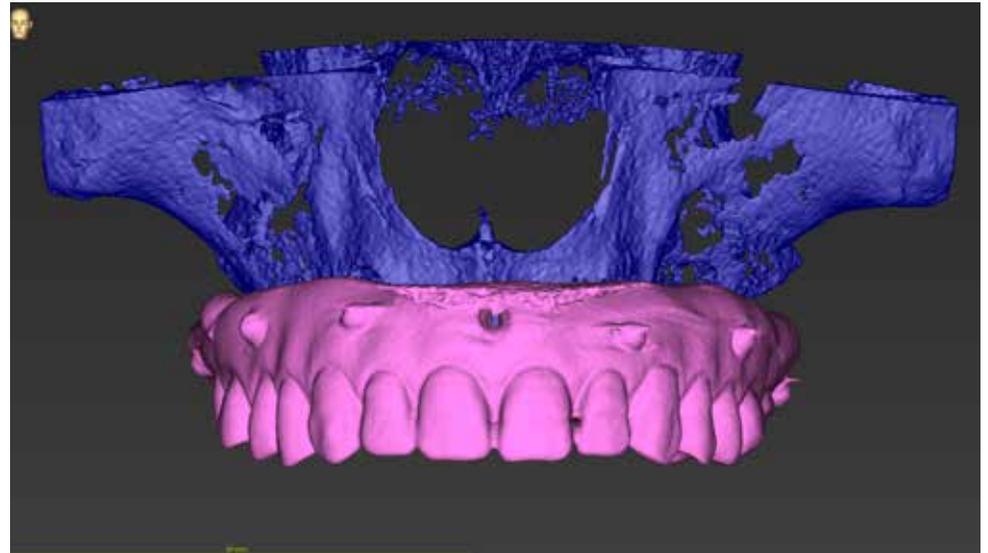
The initial situation with the immediate temporary upper denture in place, which the patient started to use a few months in advance after remaining teeth were removed.



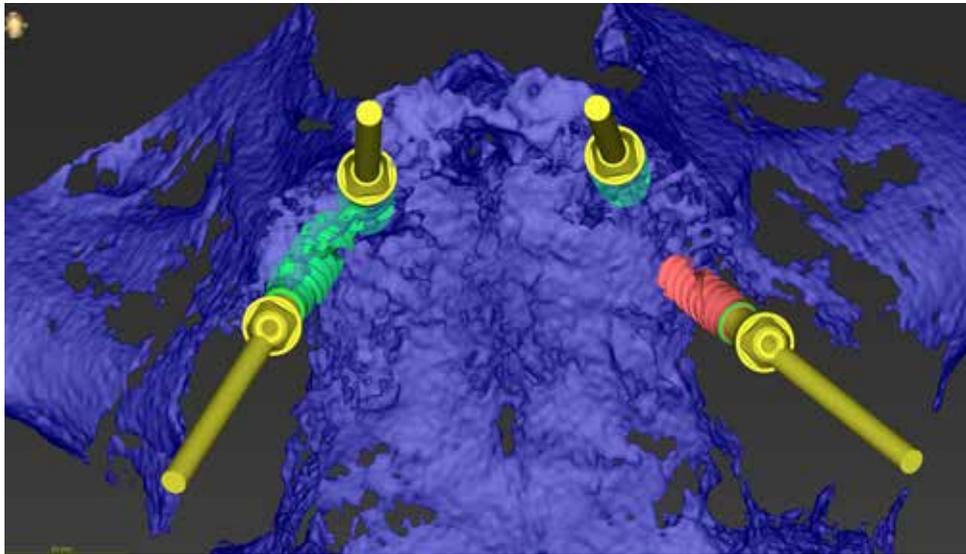
The edentulous maxilla five months after extraction of the hopeless dentition. The situation is stable, with enough volume of keratinized soft tissue.



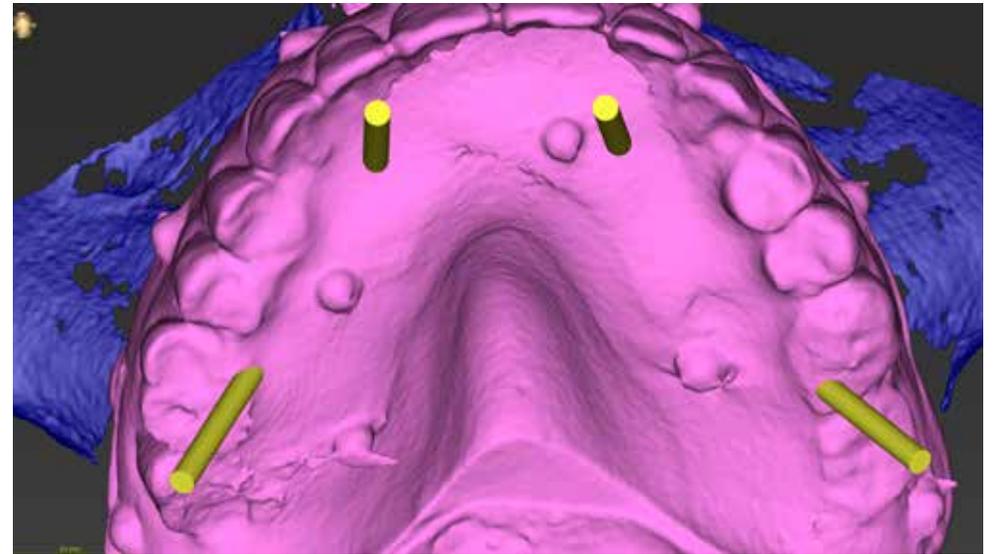
Dual scan technique was performed to obtain reliable information about the position of the teeth from the denture and bone. Existing denture of the patient was supplied with x-ray markers for the time of examination.



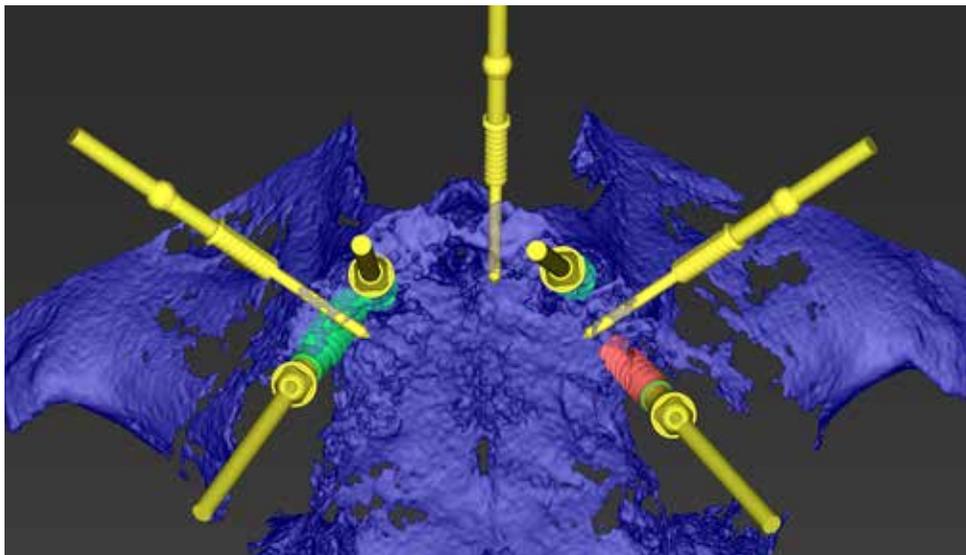
Data from the two CBCT scans are aligned in the coDiagnostiX with the x-ray markers positions as the reference.



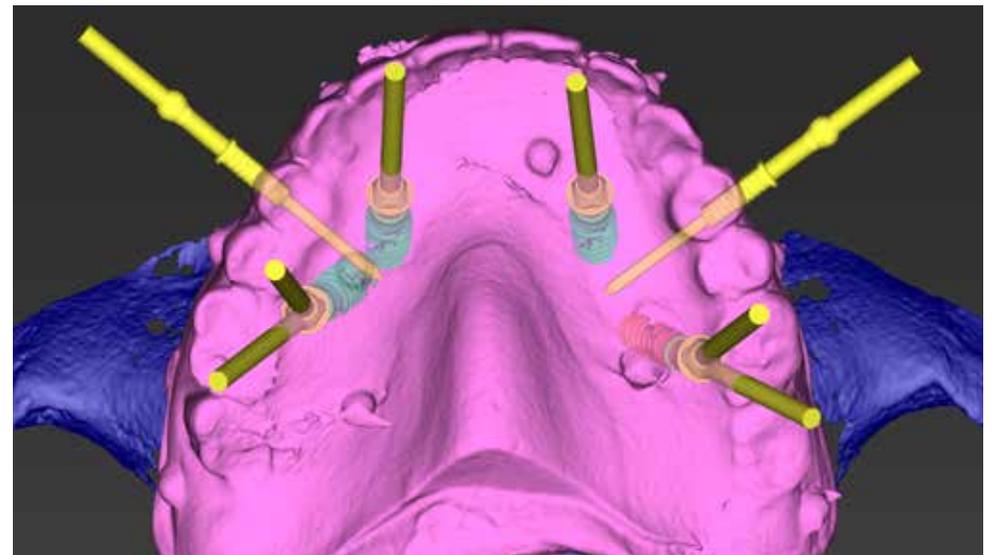
3D visualization of bone, implants, and abutments.



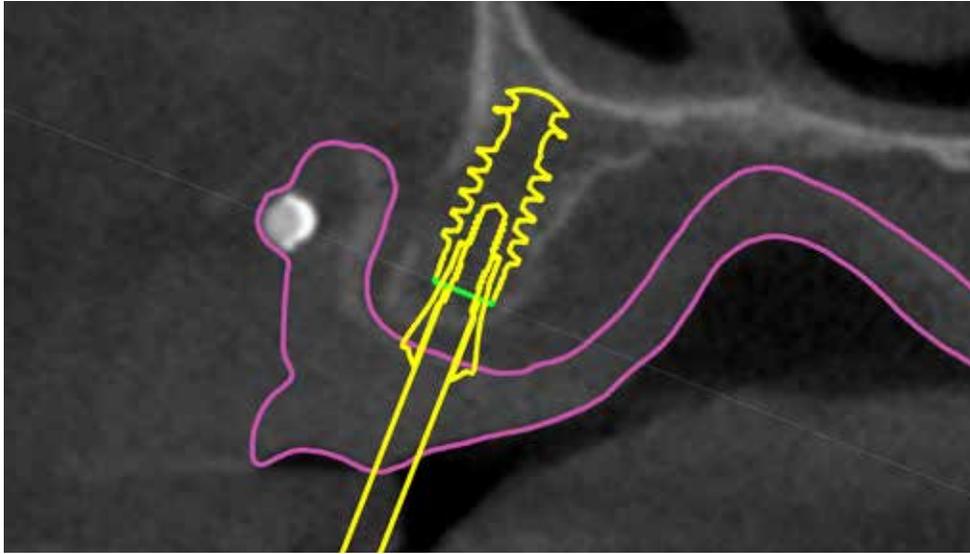
3D visualization of denture of the patient used as the x-ray template with the long axis of the implants going through the occlusal plane.



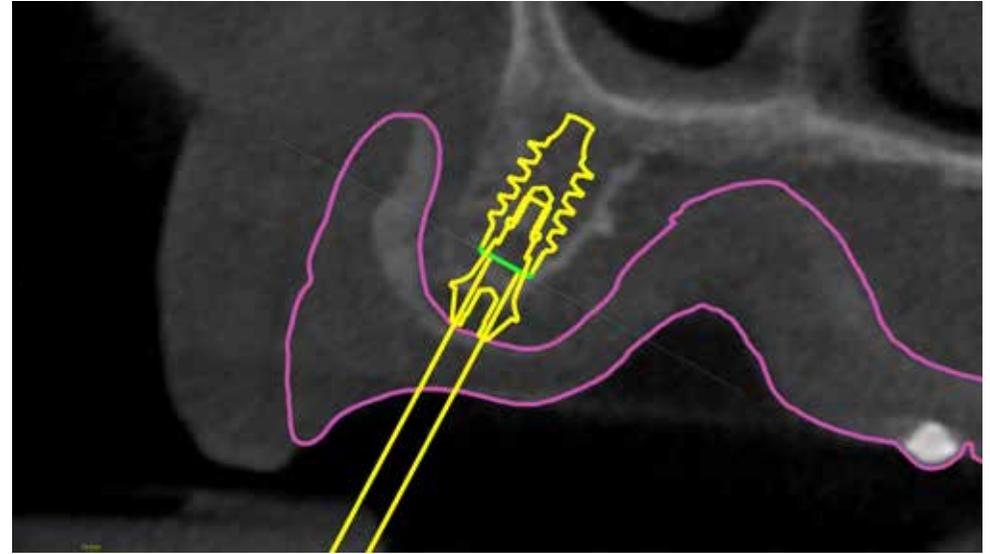
3D visualization of bone, implants, and fixation pins in place to secure future guide in place.



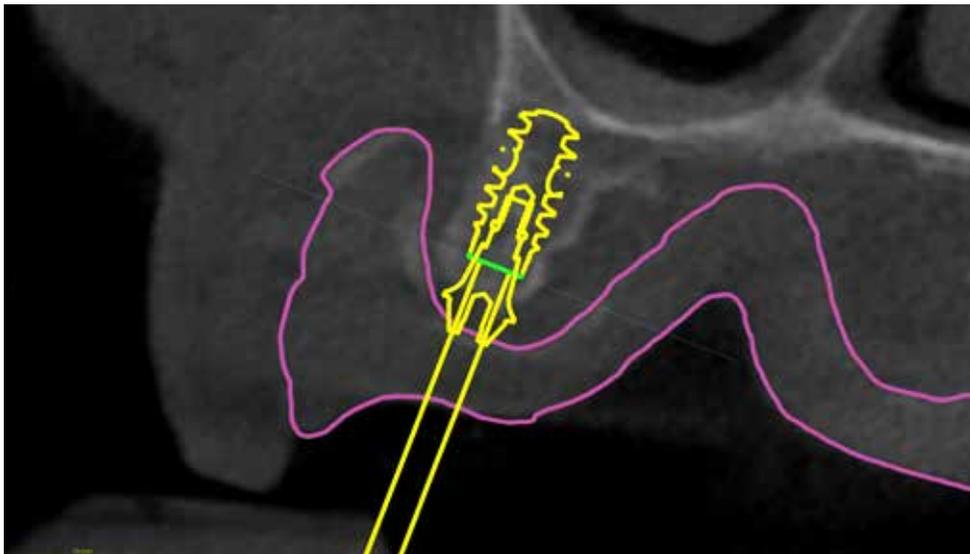
3D visualization of bone, implants, and fixation pins in place to secure guide position. 3D visualization with the transparency of the denture. The long axis of the distal implants is corrected with angulated screw-retained abutments (SRA).



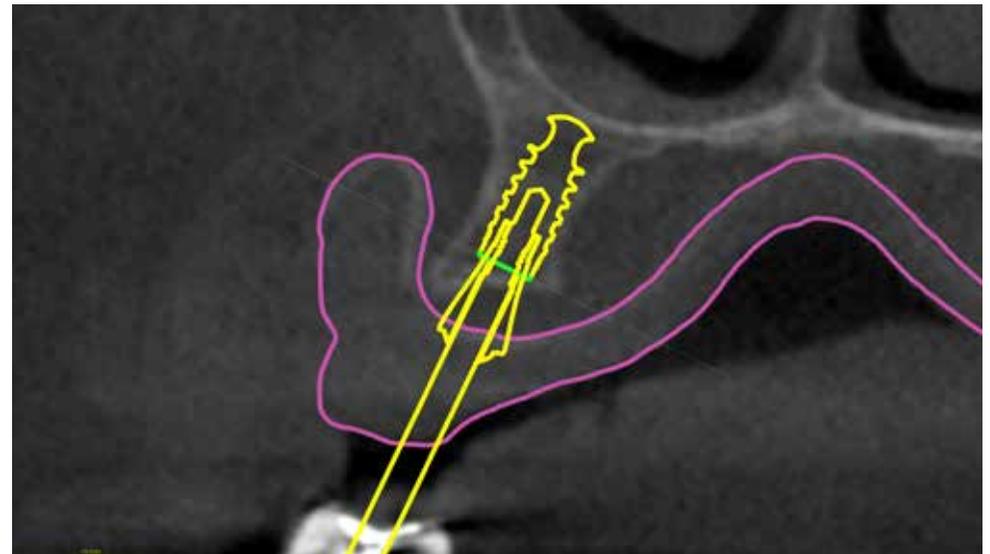
Position 14 - Initial implant planning: Bone Level X Roxolid® SLActive® (RB) D4.5/L12



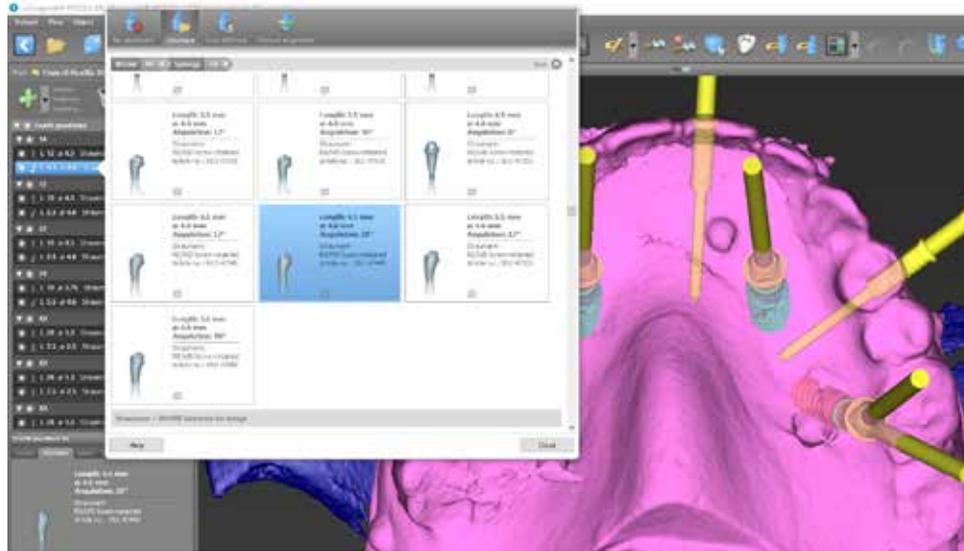
Position 12 - Initial implant planning: Bone Level X Roxolid® SLActive® (RB) D4.5/L10



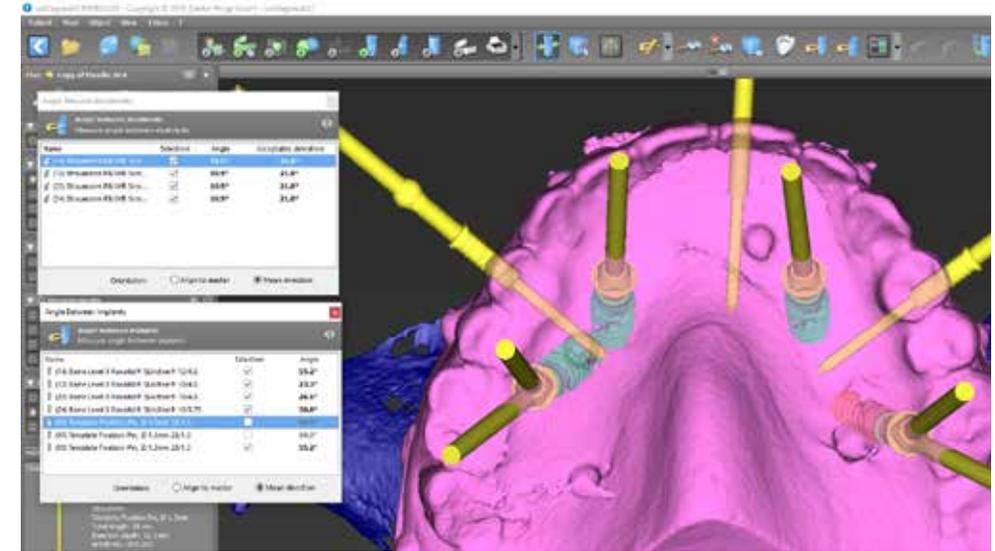
Position 22 - Initial implant planning: Bone Level X Roxolid® SLActive® (RB) D4.5/L10



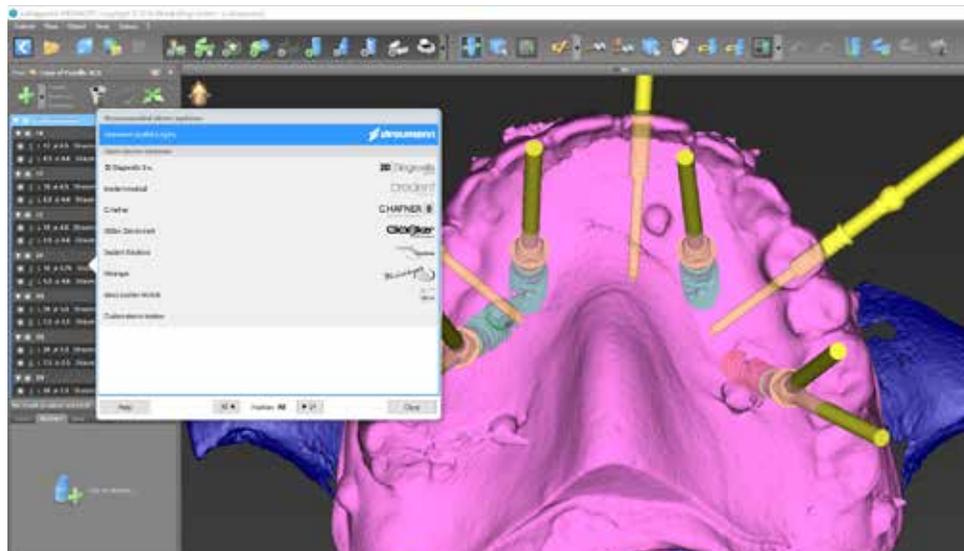
Position 24 - Initial implant planning: Bone Level X Roxolid® SLActive® (RB) D3.75/L10



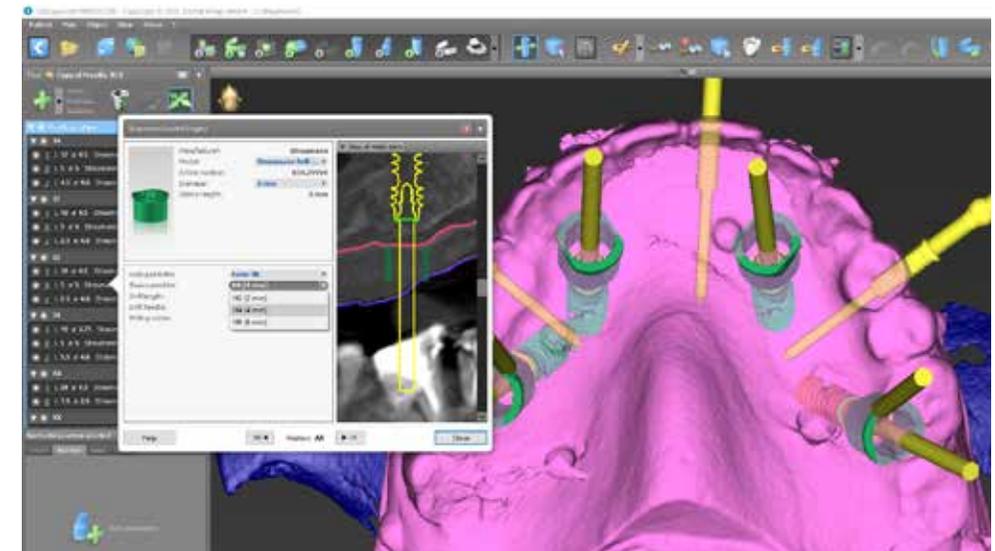
W



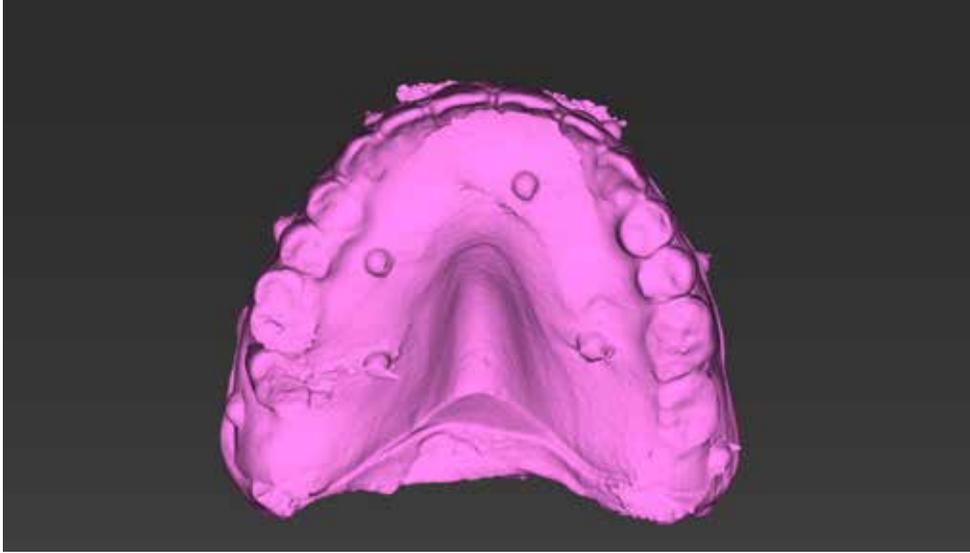
A handy feature is the angulation measurement tool. The software allows to measure the angle in between the implants and also abutments with information about acceptable deviation for insertion path of the prosthetic work.



Selection of the sleeves for the surgical guide. In the software recommended sleeve system is highlighted. Open sleeve systems from other companies are also visible.



Position of the sleeve is determined by the length of the implants, insertion depth, and thickness of the soft tissue.



From the dual scan examination, the denture is segmented and converted to the 3D object. Next, it is exported as the STL file to print the denture.



Printed denture generated from the CBCT examination.



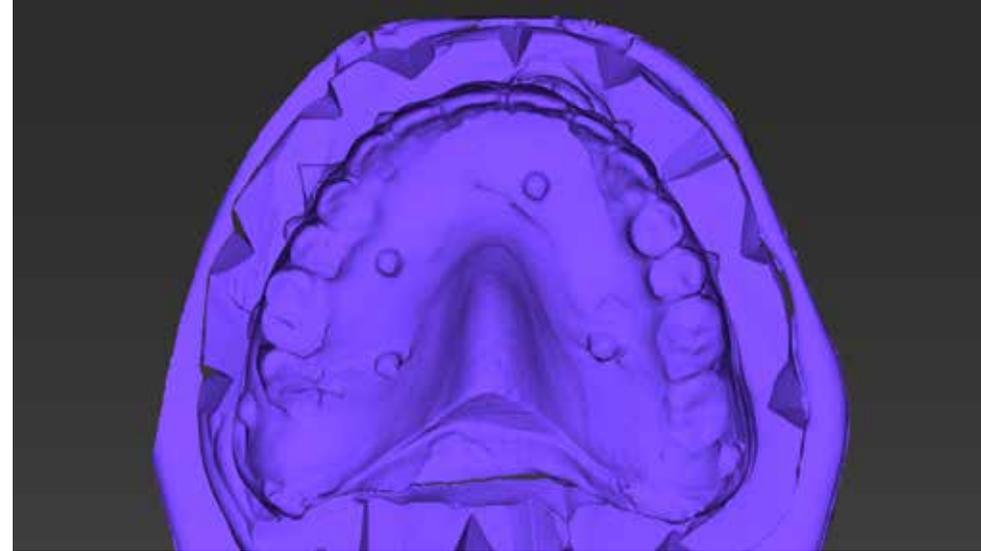
Denture serves as the base for model preparation of the soft tissue of the maxilla with A-silicones.



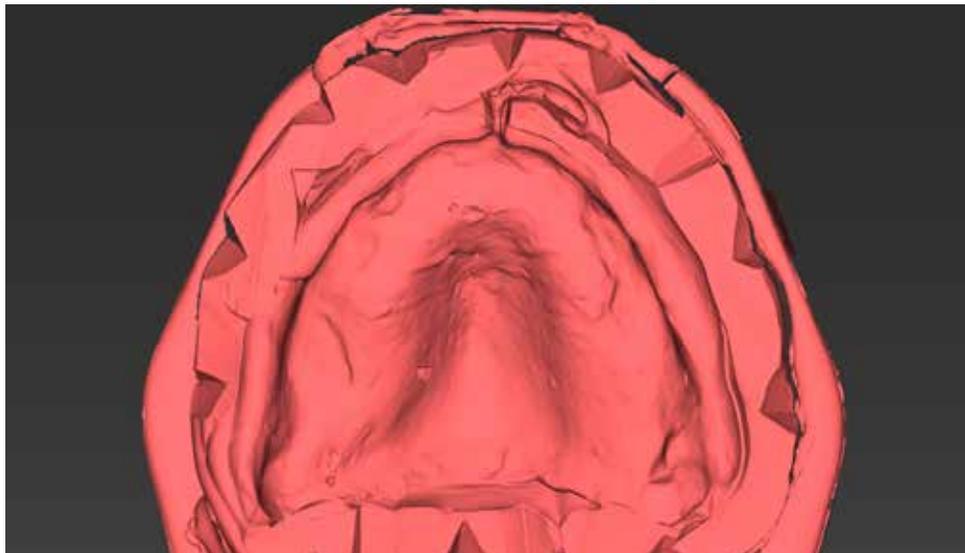
Two layers of the A-silicone were used to form the model. Polymerization continues on the glass plate.



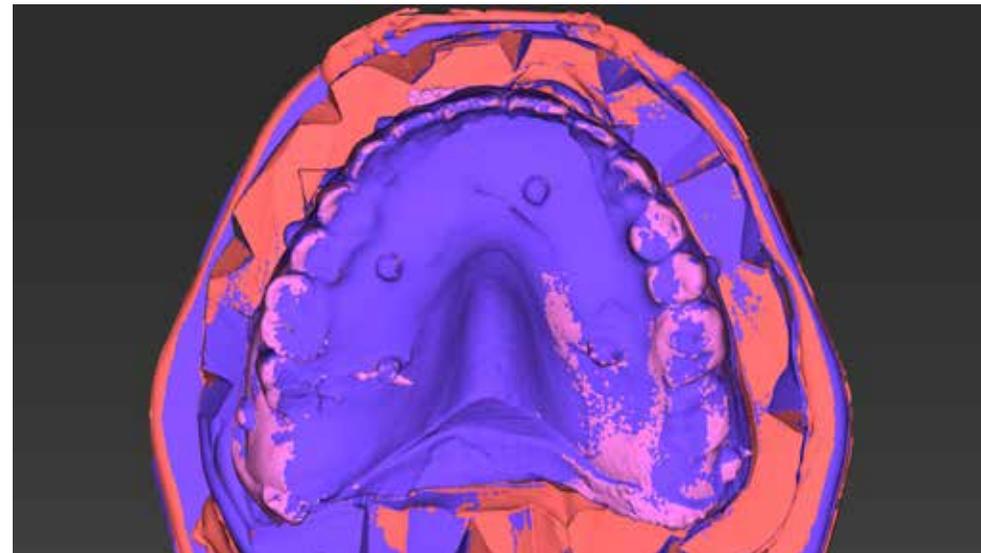
Borders of the silicone trimmed and marked with triangle cuts.



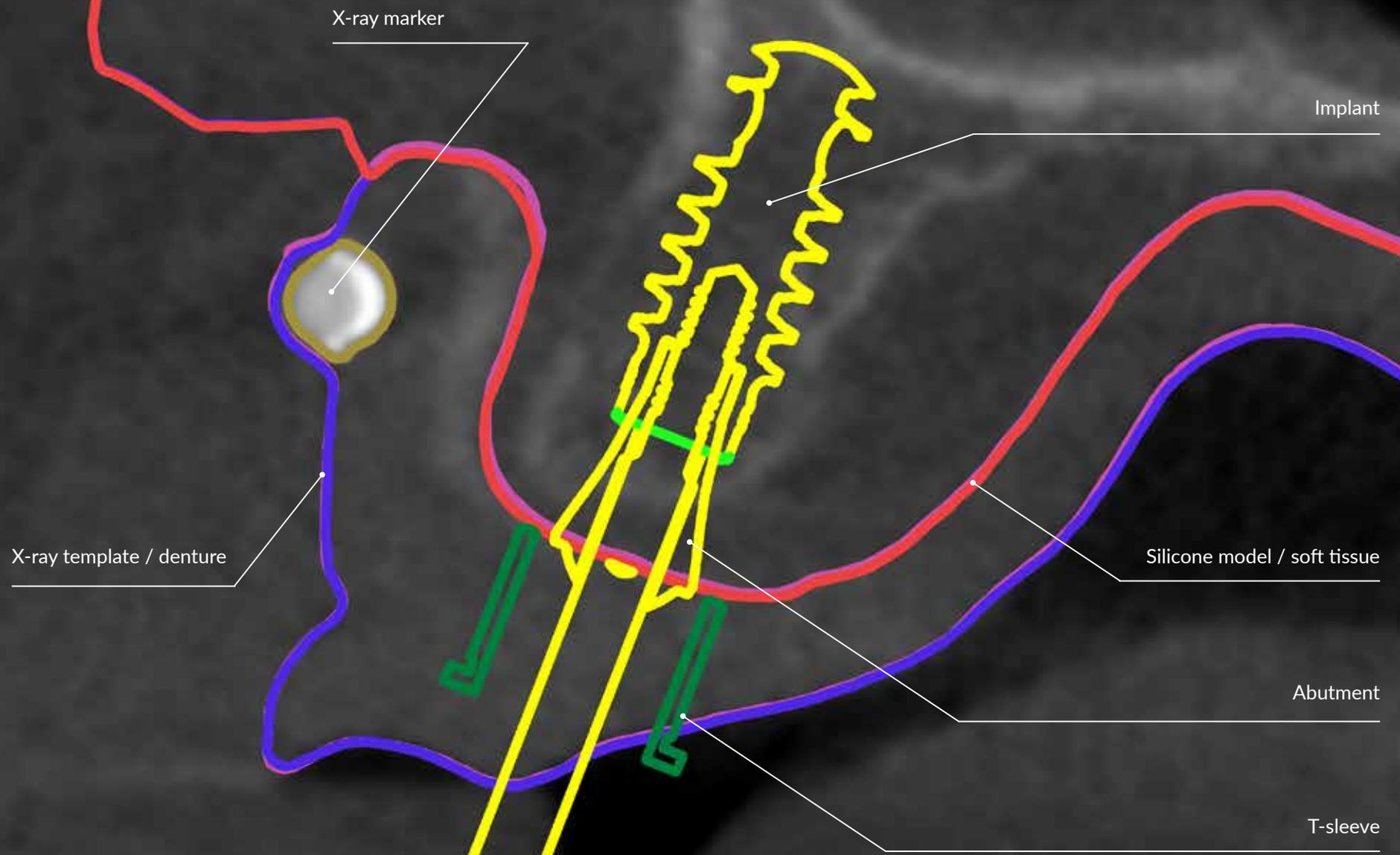
Before removing the denture, the first scan was performed.

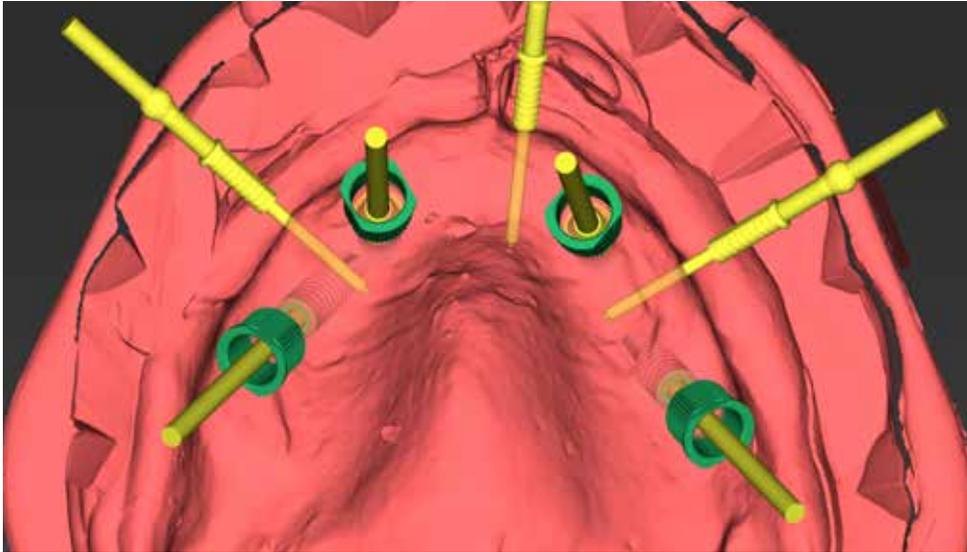


The second scan in the lab is made after the denture removal. Now we have the duplicate of the soft tissue with triangle cut markers for aligning the layers in the software.

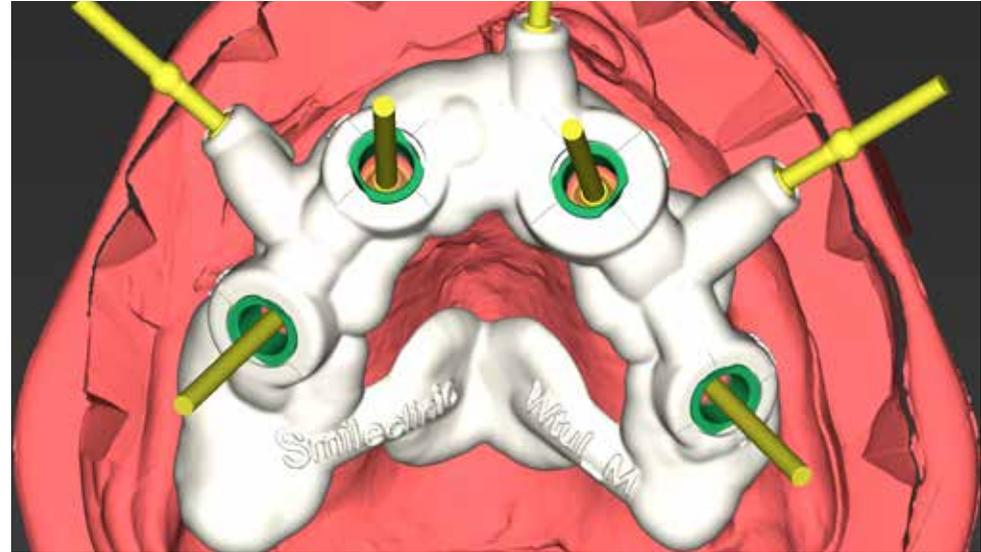


Three layers merged in the coDiagnostiX. X-ray markers in the denture and triangle cuts in the silicone model were used to align all the layers.





A surgical guide can be designed in the coDiagnostiX with the dual scan denture only, however, creating the silicone model helps to avoid difficulties in the design of the guide.



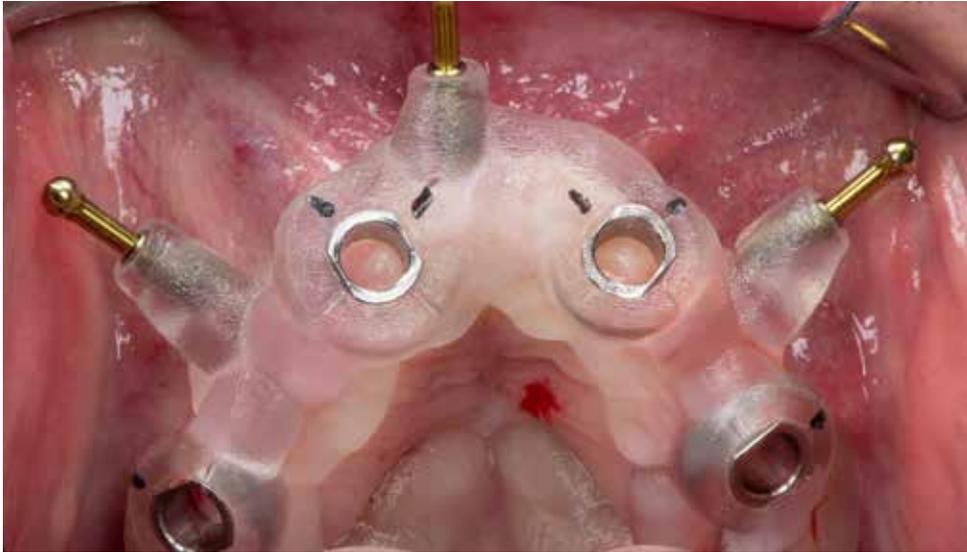
Design of the surgical guide. Three fixation pins are placed in the front and additional support on the palate gives the stability. Window exposing the palate in the anterior gives access for anesthesia delivery and its expansion in the tissue.



The surgical guide is exported and saved as the STL file for printing.



A printed guide with Straumann titanium T-sleeves in place.



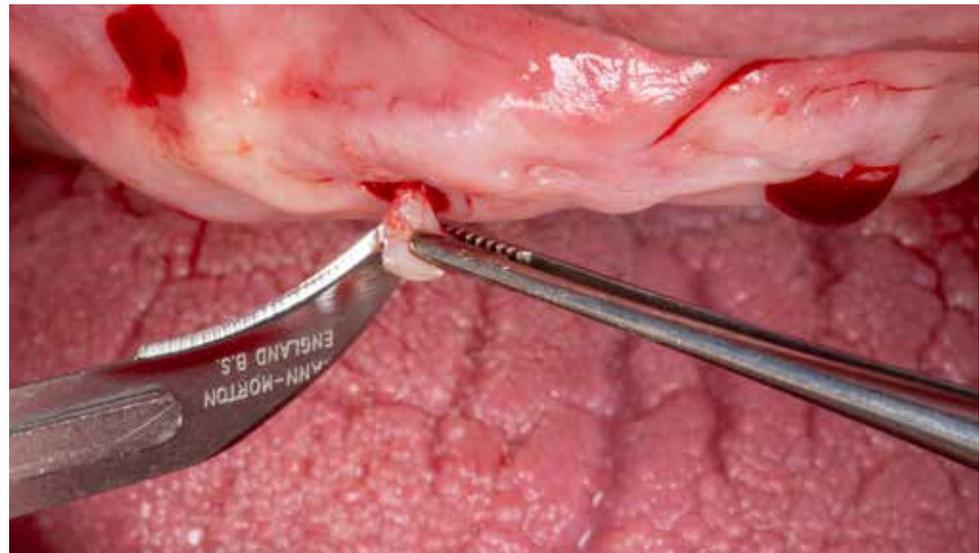
The first step is a fixation of the guide with the pins in the vestibulum. Local anesthesia delivery is in the vestibulum and the palate within the anterior window.



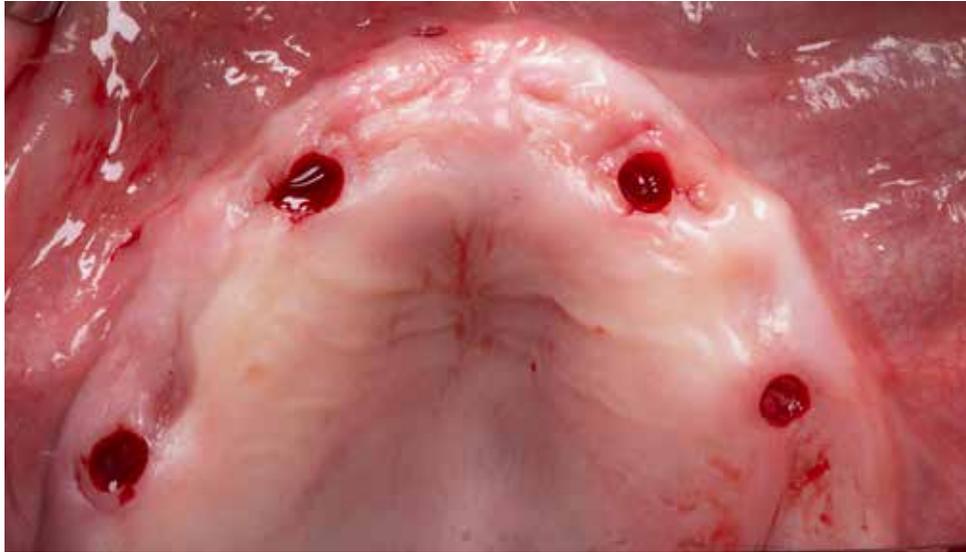
Tissue punch from the Straumann Guided Surgery Set.



The flapless procedure with the use of the tissue punch is recommended in the situations when enough volume of the keratinized soft tissue is present. Insertion depth is limited by the bone – motor speed: 50-100rpm.



The remaining soft tissue should be removed. A 12D blade is a helpful tool in releasing attached soft tissue elements.



Situation after punching the soft tissue. The large volume of the keratinized soft tissue gives stability for future results.



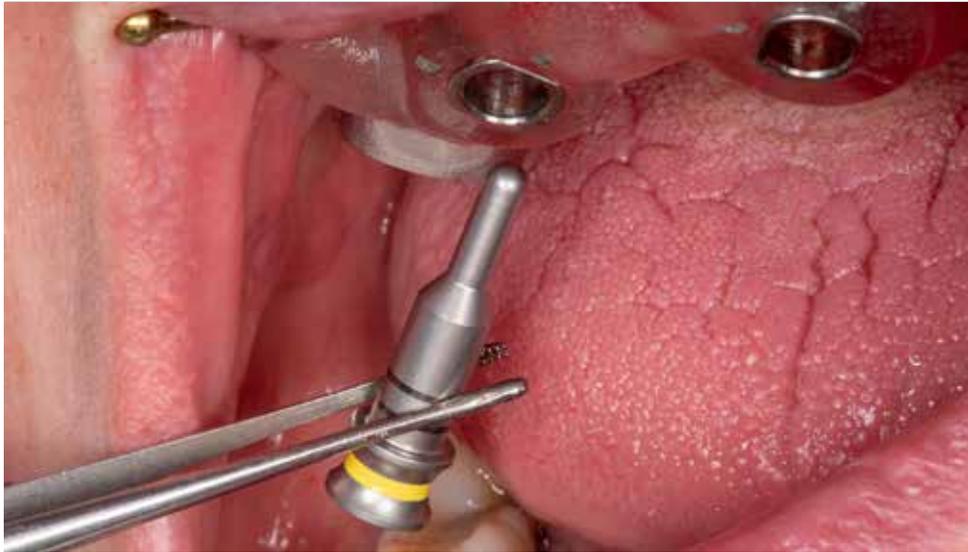
First implant bed preparation starts with the distal implants. According to the surgical plan correct length of the drill and corresponding drill handle is selected - pilot drill 2.2mm.



Straumann drills dedicated to guided surgery have stoppers allowing safe and fast osteotomy. Cooling is limited, and pumping movements with sharp instruments protect bone overheating – speed 800rpm.



Next drill in the sequence is 2.8mm in the diameter.



To achieve a more stable position of the guide, it's recommended to use additional fixation pins placed temporarily into prepared implant bony bed. The smaller diameter of the pin fits the osteotomy diameter (2.8mm)



The upper diameter of the pin (5mm) fits the inner diameter of the Straumann T-sleeve in the surgical guide.



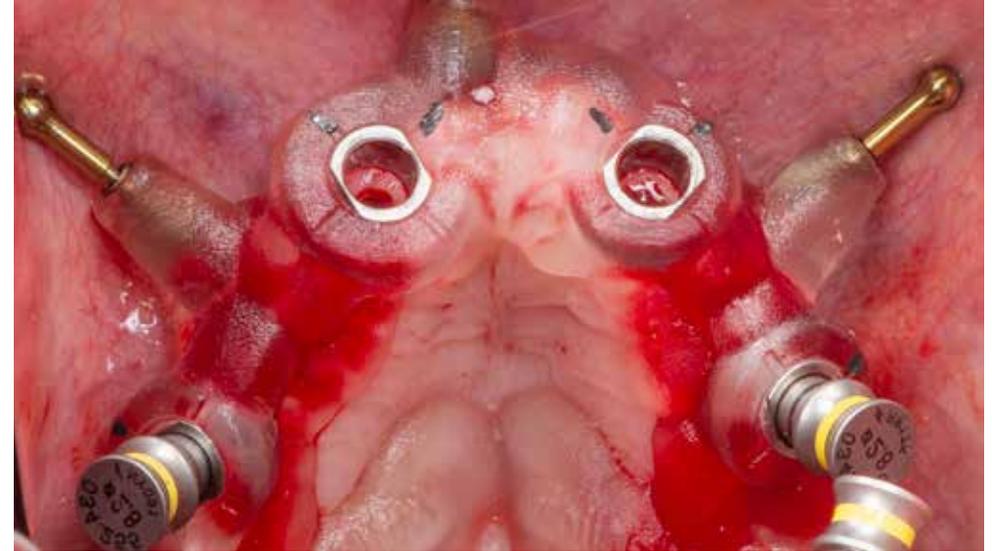
Pilot drilling with the 2.2mm drill - for osteotomy in position number 24.



The second drill with diameter 2.8mm is used to enlarge the osteotomy – speed 500rpm.



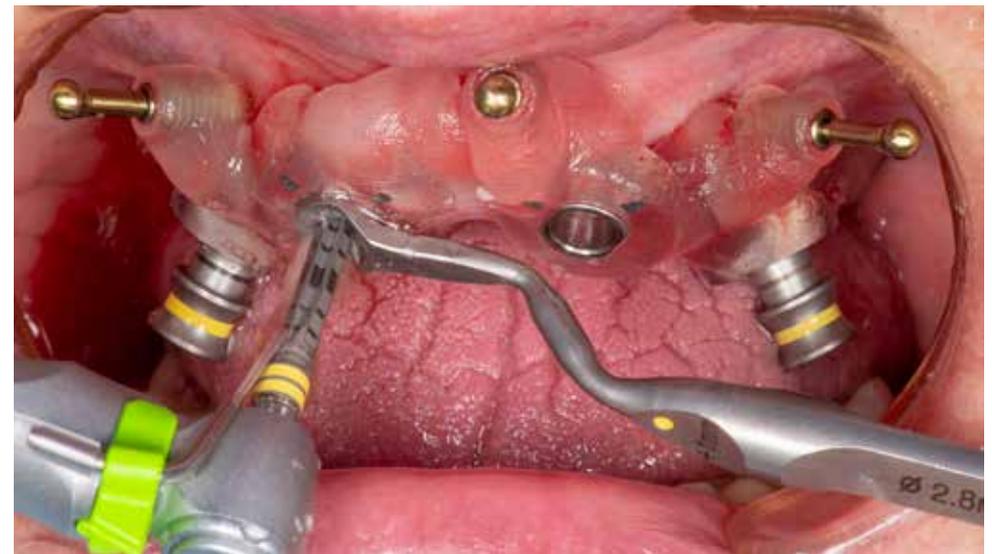
Secured position of the guide with three fixation pins in the front and two large supporting pins in the back.



Occlusal view: guide seats on the soft tissue of the ridge and palate.



Osteotomy preparation in the front position starts with pilot drill 2.0 and appropriate drill holder.



Final osteotomy with the drill 2.8mm.



Straumann BLX Roxolid SLActive implant in the sterile vial.



Implant engagement with the machine driven adapter for the BLX implant.



Straumann BLX Roxolid SLActive implant ready for placement.



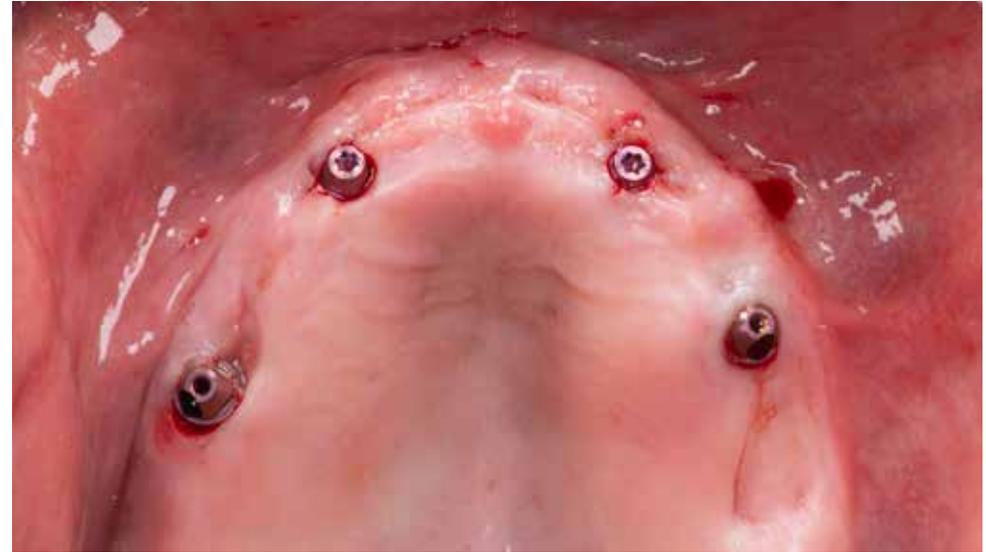
Freehand implant placement. At the time of publication, the Surgical Cassette for Guided Surgery with BLX implant was in the preparation phase.



Implant design helps to achieve excellent primary stability even in the soft bone.



Improved design of the screw-retained abutment with BLX TorcFit™ connection. Slim and under-contoured abutment design for maximized soft tissue space and predictable esthetic outcomes.



Four implants in place with screw-retained abutments. Two in the front are straight, and two distal are angled with 30 degrees angulation.



The transfer and alignment pins help to determine the alignment of the abutments and positioning.



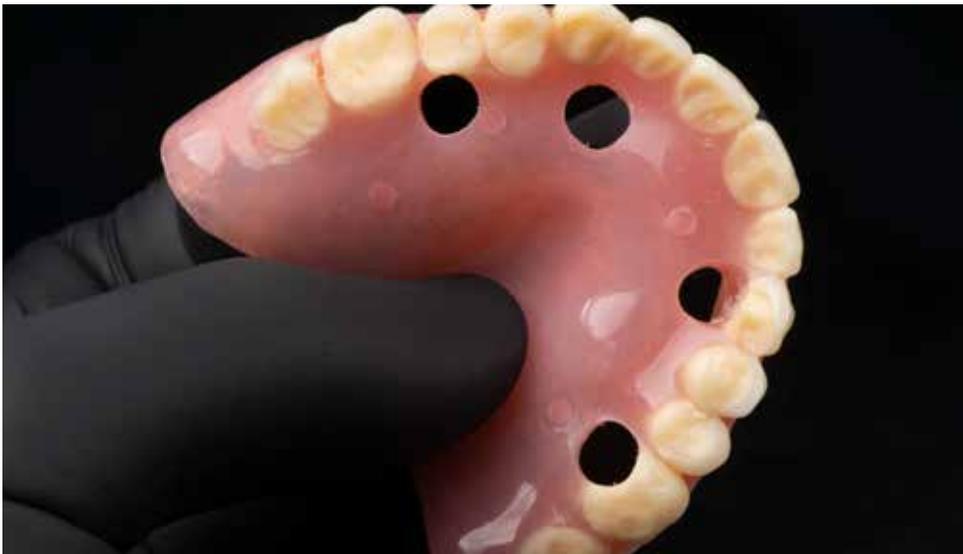
For the time of preparation of the temporary restoration four protective caps were placed.



Relining of the temporary denture with silicone material for bite registration to mark the position of the temporary caps.



Temporary denture with marked positions of the caps.



Preparation of the denture for fixation with the temporary sleeves.



Initial fixation of the denture with two temporary sleeves with acrylic material.



Position check of the additional two sleeves before fixation.



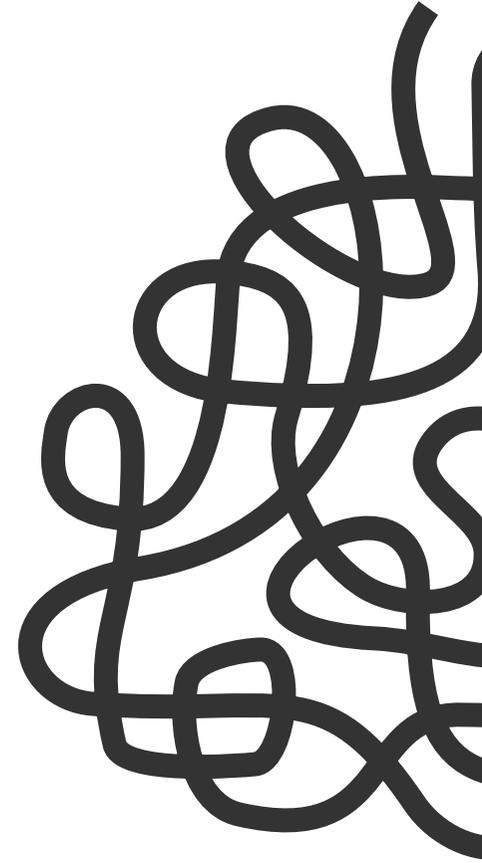
Immediate temporization based on the existing denture. Reduction of the palatal part of the denture.



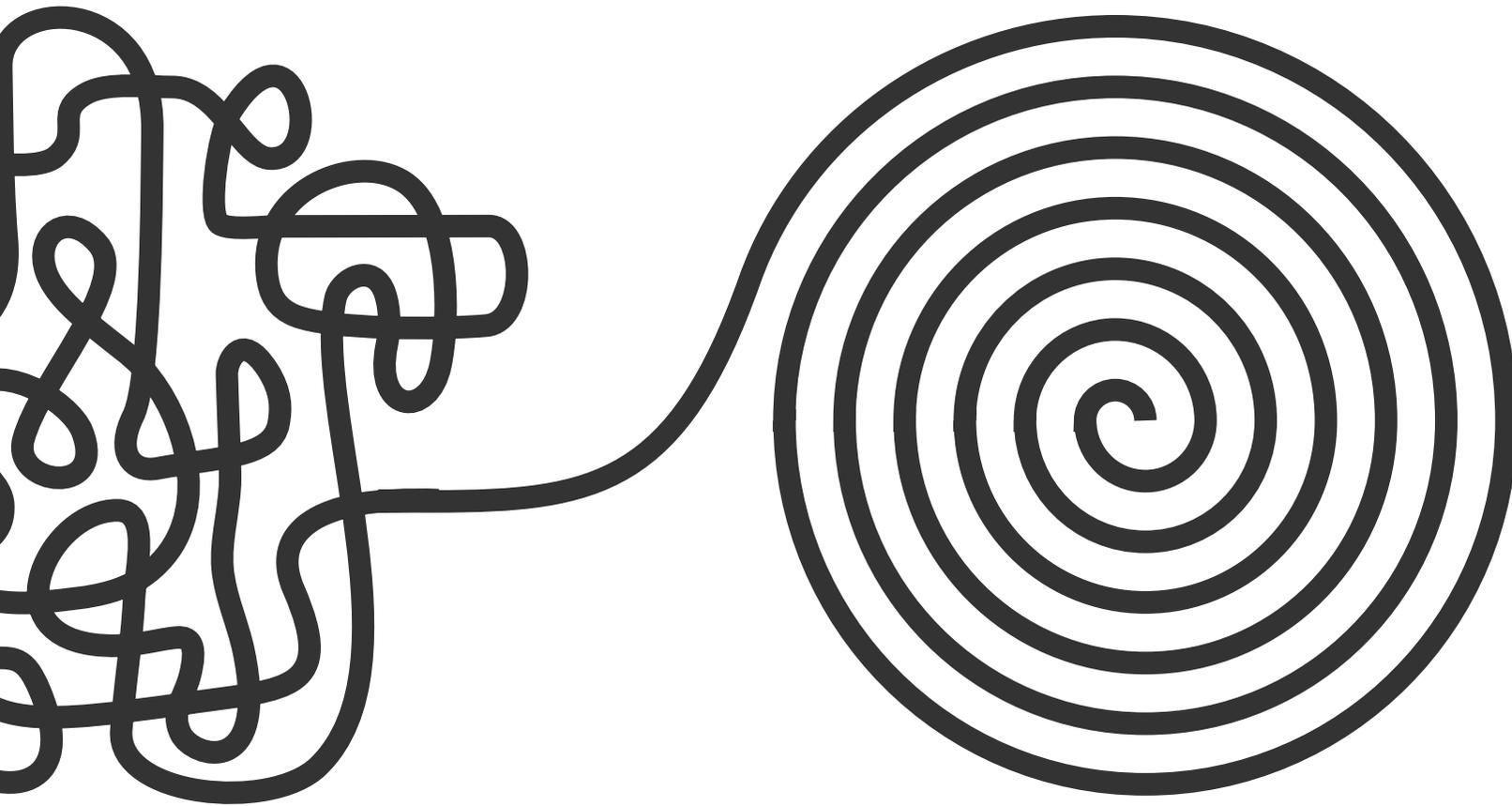
Transfer of the implants position with PIC camera.



End



How to order a guide?





How to order a guide?

For late implantation with teeth supported guide

To receive a template for computer navigation, which will enable the safe execution of the procedure, follow the proposed steps. You have two options:

- Analog - classic impressions, plaster models
- Digital - intraoral scanning, laboratory scanning

Each of these methods leads to the same result: production of a precise template for computer navigation.

Step-by-step procedure

So, what you need to do to get the teeth supported template for late implantation.

Step 1: Impressions and bite registration

An analog approach:

Take the alginate impressions of both jaws and pour the models. Register a bite

- Option 1: Ask your local laboratory to scan the models and send the STL files back to you.
- Option 2: Pack and send us models and bite registration - we will do the rest for you.
- Option 3: If you want to send us impressions, take them with a silicone material (PVS). We will pour the models and scan in our laboratory.

Digital approach:

Scan the two jaws with the intraoral scanner and save it as an open STL files.

Take digital bite registration and save as an open STL file.

Step 2: CBCT

CBCT examination:

Position the Patient's head in the CBCT according to the planes of orientation.

The upper and lower jaw must be separated during the examination. Place the positioner between the teeth or any radiolucent element to take the scan in the open bite.

Recommended FOV 10x5cm, 10x10cm (limited FOV5x5cm)

Exporting data:

IMPORTANT: Save data as uncompressed and unencrypted DICOM files in a separate folder.

Sending data:

Option 1: Online transfer.

- Compress the folder with DICOM data using dedicated software (WinZIP, WinRAR, Hamster ZIP Archiver).
- Send compressed folder using WeTransfer.

Option 2: Courier service.

Save the folder with uncompressed DICOM files to a CD/DVD or pendrive and send it to us using the UPS service. Pay attention to the safe packaging to avoid damage.

Step 3: Planning the implants

For the transferred data, attach a description of the planned treatment, which should contain information on the region of implantation, type of implantation, preferred implant brand, model and size of the implant and type of planned prosthetic restoration.

Planning approval:

After receiving your case, we will confirm this fact by phone or via e-mail or text message.

After the initial planning, we will send you a pdf report and cost evaluation. A template for navigation will be planned based on the report and your comments.

IMPORTANT: before the template is produced, the planning must be approved by the ordering dentist – acceptable forms of approval: written or email.

If the treatment plan is rejected, the new plan will be submitted for approval. You can also cancel your order after this step if there is not enough bone volume for the procedure or if you change your plan.

Step 4: Creating a guide for computer navigation

Print:

- You can send us your template as an open STL file and we will print it.
- You can also send a guide design made in coDiagnostiX™, and we will export it as an open source STL file ready for printing.
- Your template will be printed on one of the most precise Stratasys Objet 260 Dental Selection printers from certified medical materials.
- After printing, the template is thoroughly cleaned and can be delivered with or without sleeves.
- Do not sterilize the template in the autoclave. Acceptable methods include EtO or plasma sterilization. The most effective form of disinfection is to immerse the template in 70% alcohol for 15 minutes.

Step 5: Temporary restoration [option]

Using dedicated software, we can design and make temporary restorations:

- Individual healing screw based on TiBase (Variobase) made of PMMA.
- Screw-retained temporary crowns (PMMA and TiBase).

Step 6: Delivery

Deliveries are sent from our office every working day (Mon-Fri) except public holidays. The standard delivery time is counted in working days. We also offer express delivery. Standard UPS delivery: within 48 hours (from approval of the project or receiving STL file for printing) in Poland. You will receive confirmation and tracking number.



How to order a guide?

For immediate implantation with teeth supported guide

IMPORTANT INFORMATION:

In order to prepare the template for immediate implantation, we recommend sending us plaster models before removing the tooth from the model.

You can also send open digital files (STL). Based on the received files the 3D model will be printed, which will be used to create the template.

Step-by-step procedure

So, what you need to do to get the teeth supported template for immediate implantation.

Step 1: Impressions and bite registration

An analog approach:

Take the alginate impressions of both jaws and pour the models. Register a bite

- Option 1: Ask your local laboratory to scan the models and send the STL files back to you.
- Option 2: Pack and send us models and bite registration - we will do the rest for you.
- Option 3: If you want to send us impressions, take them with a silicone material (PVS). We will pour the models and scan in our laboratory.

Digital approach:

Scan the two jaws with the intraoral scanner and save it as an open STL files.

Take digital bite registration and save as an open STL file.

Step 2: CBCT

CBCT examination:

Position the Patient's head in the CBCT according to the planes of orientation.

The upper and lower jaw must be separated during the examination. Place the positioner between the teeth or any radiolucent element to take the scan in the open bite.

Recommended FOV 10x5cm, 10x10cm (limited FOV5x5cm)

Exporting data:

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Sending data:

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Option 2: Courier service.

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Step 3: Planning the implants

For the transferred data, attach a description of the planned treatment, which should contain information on the region of implantation, type of implantation, preferred implant brand, model and size of the implant and type of planned prosthetic restoration.

Planning approval:

After receiving your case, we will confirm this fact by phone or via e-mail or text message.

After the initial planning, we will send you a pdf report and cost evaluation. A template for navigation will be planned based on the report and your comments.

IMPORTANT: before the template is produced, the planning must be approved by the ordering dentist – acceptable forms of approval: written or email.

If the treatment plan is rejected, the new plan will be submitted for approval. You can also cancel your order after this step if there is not enough bone volume for the procedure or if you change your plan.

Step 4: Creating a guide for computer navigation

Print:

- You can send us your template as an open STL file and we will print it.
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Using dedicated software, we can design and make temporary restorations:

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How to order a guide?

For free end situations

IMPORTANT INFORMATION:

To obtain optimal information about the thickness of the mucosa and the position of the teeth, it is recommended to make a radiological template before taking the radiological examination (CT/CBCT).

Step-by-step procedure

So, what you need to do to get the teeth, mucosa and bone supported template for late implantation in the free end cases.

Step 1: Impressions and bite registration

An analog approach:

Take the alginate impressions of both jaws and pour the models.

Register a bite with wax rims.

- Option 1: Ask your local laboratory to prepare the radiological template with x-ray markers.
- Option 2: Pack and send us models and bite registration with wax rims - we will do the rest for you.
- Option 3: If you want to send us impressions, take them with a silicone material (PVS). We will pour the models and prepare the radiological template with x-ray markers and we will send it back to you with clear instruction step by step how to perform the examination.

Step 2: CBCT

CBCT examination: Dual Scan Technique

First scan:

- Before performing the examination, the radiological template must be relined with the silicone impression material and then placed in the patient's mouth for the examination in the open bite.
- Position the Patient's head in the CBCT according to the planes of orientation and use a positioner with beard support (do not use a positioner between the teeth).
- Recommended FOV field 10x5cm, 10x10cm.

Second scan

Perform the second CBCT examination of the radiological template itself according to the guidelines of the Dual Scan technique.

Exporting data:

IMPORTANT: Save data as uncompressed and unencrypted DICOM files in a separate folder.

Sending data:

Option 1: Online transfer.

- Compress the folder with DICOM data using dedicated software (WinZIP, WinRAR, Hamster ZIP Archiver).
- Send compressed folder using WeTransfer.

Option 2: Courier service.

Save the folder with uncompressed DICOM files to a CD/DVD or pendrive and send it to us using the UPS service. Pay attention to the safe packaging to avoid damage.

Step 3: Planning the implants

For the transferred data, attach a description of the planned treatment, which should contain information on the region of implantation, type of implantation, preferred implant brand, model and size of the implant and type of planned prosthetic restoration.

Planning approval:

After receiving your case, we will confirm this fact by phone or via e-mail or text message.

After the initial planning, we will send you a pdf report and cost evaluation. A template for navigation will be planned based on the report and your comments.

IMPORTANT: before the template is produced, the planning must be approved by the ordering dentist – acceptable forms of approval: written or email.

If the treatment plan is rejected, the new plan will be submitted for approval. You can also cancel your order after this step if there is not enough bone volume for the procedure or if you change your plan.

Step 4: Creating a guide for computer navigation

Print:

- You can send us your template as an open STL file and we will print it.
- You can also send a guide design made in coDiagnostiX™, and we will export it as an open source STL file ready for printing.
- Your template will be printed on one of the most precise Stratasys Objet 260 Dental Selection printers from certified medical materials.
- After printing, the template is thoroughly cleaned and can be delivered with or without sleeves.
- Do not sterilize the template in the autoclave. Acceptable methods include EtO or plasma sterilization. The most effective form of disinfection is to immerse the template in 70% alcohol for 15 minutes.

Step 5: Temporary restoration [option]

The possibilities of temporary restorations depend on the number of implants. In order to achieve passive seating, it is required to connect the structure elements in the mouth by a doctor.

Step 6: Delivery

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Szablon przy bezzębieniu

How to order a guide?

For edentulous cases

IMPORTANT INFORMATION:

To obtain optimal information about the thickness of the mucosa and the position of the teeth, it is recommended to make a radiological template before taking the radiological examination (CT/CBCT).

Step-by-step procedure

So, what you need to do to get the template for edentulous cases with mucosa support and bone stabilization with the pins.

Step 1: Impressions and bite registration

An analog approach:

Take the alginate impressions of both jaws and pour the models.

Register a bite with wax rims.

- Option 1: Ask your local laboratory to prepare the radiological template with x-ray markers.
- Option 2: Pack and send us models and bite registration with wax rims - we will do the rest for you.
- Option 3: If you want to send us impressions, take them with a silicone material (PVS). We will pour the models and prepare the radiological template with x-ray markers and we will send it back to you with clear instruction step by step how to perform the examination.

Step 2: CBCT

CBCT examination: Dual Scan Technique

First scan:

- Before performing the examination, the radiological template must be relined with the silicone impression material and then placed in the patient's mouth for the examination in the open bite.
- Position the Patient's head in the CBCT according to the planes of orientation and use a positioner with beard support (do not use a positioner between the teeth).
- Recommended FOV field 10x5cm, 10x10cm.

Second scan

Perform the second CBCT examination of the radiological template itself according to the guidelines of the Dual Scan technique.

Exporting data:

IMPORTANT: Save data as uncompressed and unencrypted DICOM files in a separate folder.

Sending data:

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IMPORTANT: before the template is produced, the planning must be approved by the ordering dentist – acceptable forms of approval: written or email.

If the treatment plan is rejected, the new plan will be submitted for approval. You can also cancel your order after this step if there is not enough bone volume for the procedure or if you change your plan.

Step 4: Creating a guide for computer navigation

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What you'll learn and what you'll find in this book:

- Why you should use computer navigation in implantology
- How to perform x-ray for implant planning
- Digitalization of impressions and models
- Intraoral and laboratory scanners
- What are the types of templates for computer navigation
- Techniques for fixing templates
- Which technique is the most accurate?
- Methods for creating templates for navigation
- 3D printing techniques
- Sterilization or disinfection of the template?
- Clinical cases
- How to order a template for navigation



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