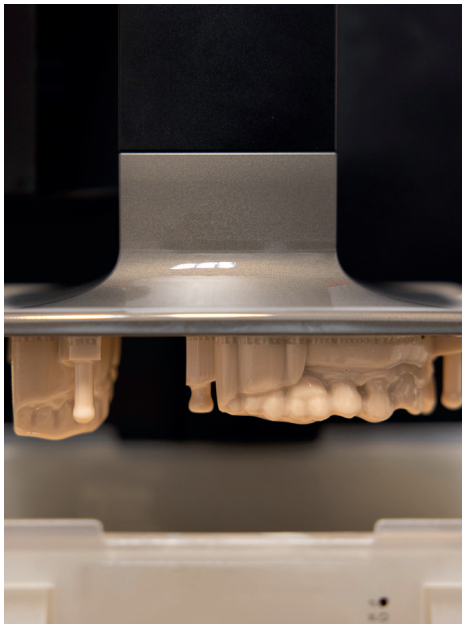
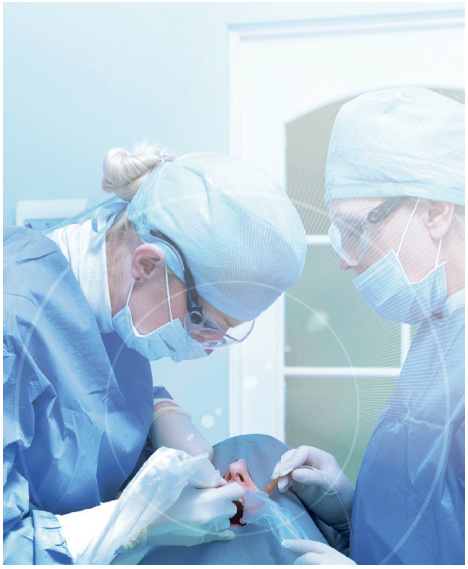
GUIDED SURGERY





PERFORM SUCCESSFUL CT-SCANS

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DIGITAL DENTAL PROTOCOLS
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INTRODUCTION

The use of the guided surgery software requires adapted and readable files. The whole document, made of independent information sheets, will allow you to learn and perform the adapted actions or to provide a work support to the associated professionals: dental laboratories and radiology centers.

PREREQUESITES FOR A SURGICAL GUIDE ACQUISITION

The manufacturing of a surgical guide perfectly adjusted to the patient's morphology requires a model reflecting all its characteristics.

Then, for a use of the software leading to a guided surgery, there are two choices:

• The double CT-scan technique

We will use a radiological guide equipped with radio-opaque markers. The guide will be then scanned once on the patient and once alone. The association with the radio-opaque markers will allow replacing the guide in relation with the bone volume. The guide's manufacturing will be based on its volume shape.

• For the radiological guide manufacturing see information pages 3-4.

• For this technique's CT-scanning steps,
see information pages 5-8.

• The single CT-scan technique

It is based on a single CT-scan of the patient and a plaster model of the related area. The insertion of the scanned plaster model in the three dimension work space will be done thanks to the correspondence of identical surfaces, most likely the supra-gingival elements (shape of the teeth, cuspids, etc...). This is why this technique is only meant for partially edentulous patients. The information provided by the plaster model will allow manufacturing a guide perfectly adapted to the soft tissue and remaining teeth.

• For the scanning steps and patient prerequisites,
refer to information pages 7-8.

Note: please respect carefully these two techniques' protocol, so that they can be used in the framework of a guided surgery. It is therefore mandatory to adopt the right strategy before planning.

FILE FORMAT

The processing of the DICOM pictures requires them to be exploitable and accessible.

All the files should be at the .dcm format, without the presence of a viewer as the radiology centers are used to. Indeed, a majority of the viewers are under closed license and prevent the source files from being extracted.

Follow the advised settings in every information sheet as well.

PREPARING A RADIOLOGICAL GUIDE

PRINCIPLE

The designing of the surgery guide needs a model adapted to the patient's soft tissue. It can be obtained in two ways:

• by scanning a plaster model (partially edentulous only)

• by making a radiological guide.

The radiological guide will be then scanned a first time with the patient and a second time alone (double CT-scan procedure). Previously equipped with radio-opaque reference points, the software will then be able to replace the guide in relation to the bone volume.

This document's goal is to explain how to realize a radiological guide allowing you to obtain optimal results with the planning software.

Note: For a fully edentulous person, the existing prosthesis can be used as a radiological guide by placing on it radio-opaque reference points, provided that said prosthesis is free of any metallic components.

MAKING A RADIOLOGICAL GUIDE

The making of a radiological guide is the same as for a splint. If you wish to use the patient's existing prosthesis, refer directly to the following chapter "Place the radiological reference points".

In the case of a patient that does not have a prosthesis usable as radiological guide, you can make one or have one made by your laboratory.

• Make a mucosa and tooth supported splint (in the case of a partially edentulous patient) of about 3 mm thickness. We advise the use of acrylic resin or even wax and not to use any metallic components, those would create artifacts during the scan.

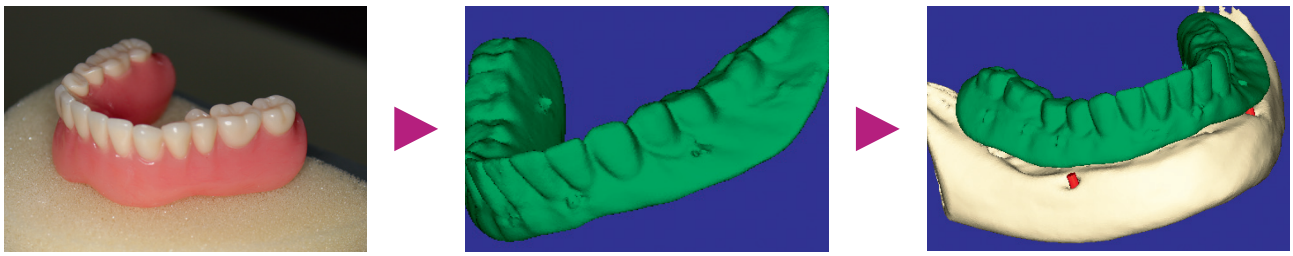
• Verify the adjustment of the radiological guide on the patient's mucosa and teeth; you must prevent the guide to tip over. If it is not stable, fill in the guide to assure its good positioning.

• Extend the radiological guide beyond the area to implant, particularly by adding posterior supports (where the anchor pins for the surgery are hard to place).

• Extend the material in the vestibule region, at posterior and mesial level, towards the top (in the maxilla) or the bottom (in the mandible).This material addition will allow you to have more surface to place the anchor pins while staying away from the areas where implants are to be placed.

• If the guide is tooth-supported, make lateral openings on the guide where it leans on teeth; these windows will allow you to see whether the guide is properly positioned.
Be careful not to keep crowns with CrCo sleeves, which generate artifacts.

• Regarding the maxilla, cover the whole palate in order to ensure the maximum stability of the future surgical guide.

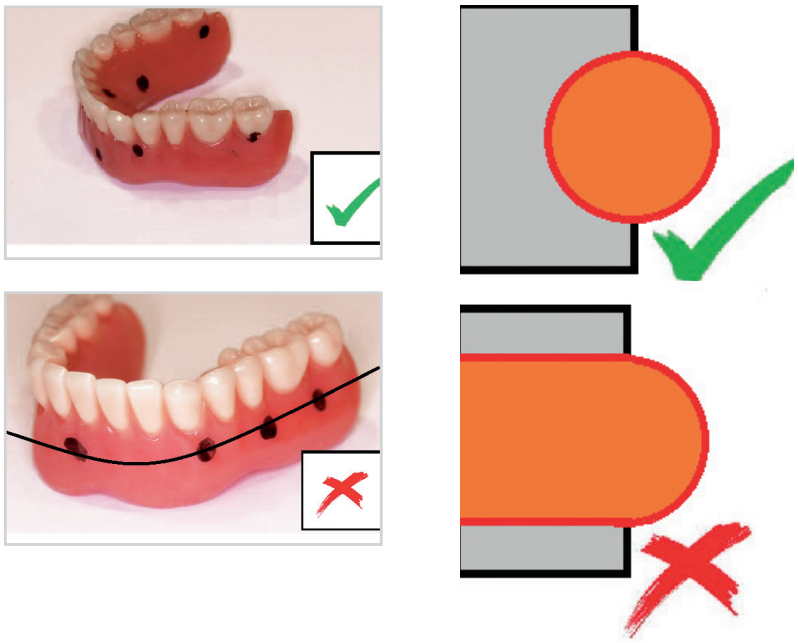


Note: a radiological guide can be fabricated from a « molding » of the patient's plaster model, it will considerably reduce the total price. Make sure that the impression is recent and respect the previous advices.

PLACE THE REFERENCE POINTS

In order to be repositioned by the software, the radiological guide has to wear radio-opaque markers allowing the guide to be repositioned in relation with the bone volume. The radio-opaque markers can be of different kinds, however, etk recommends the use of Gutta-Percha or zirconium or tantalum points (maximum 1mm of diameter), as the automatic assimilation of the scan is more performant with those three elements.

- Make 6 to 8 spherical holes of around 1 to 1.5mm diameter in the radiological guide.
- Make sure that those points are not linear, place them in different planes.
- Never completely drill through the guide while making the holes.
- Fill in the holes with radiopaque material: gutta dot or preferably zirconia bead.



The radio-opaque markers can either be placed on the inside or the outside of the prosthesis. If the previously specified dimensions are not respected, it can lead to a failure of the radiological guide assimilation process.

Note: place the radiological markers under the gingival line on the mandible and over the gingival line in the maxilla, they will be more legible in case of a restoration on the opposite maxilla.

ADVICES

• Carefully respect the above mentioned instructions. If the radiological guide is not assimilated by the software, the patient will have to be scanned again. Indeed, a modification in the placement or the addition of the radio-opaque markers on the prosthesis means that the whole double scan process will have to be realized again.

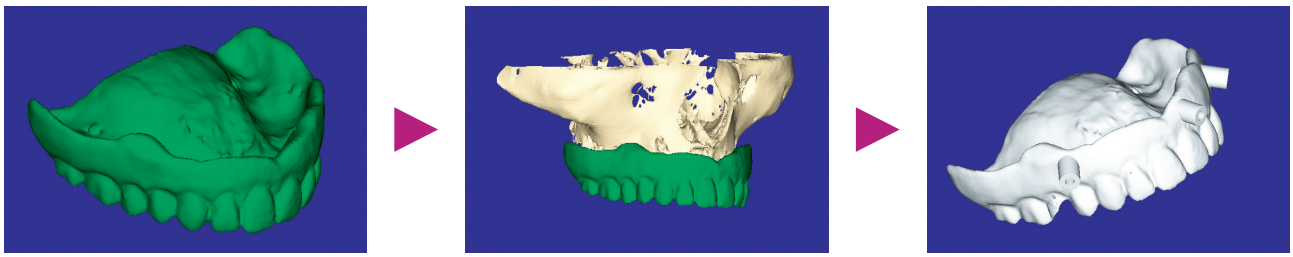
• Instruct your patient not to move during the procedure; a movement would lead to a deformation of the radio-opaque markers that would not be therefore recognized by the software.

DOUBLE SCAN PROCEDURE

PRINCIPLE

This document's goal is to facilitate the scanning for the double scan technique relating to the use of the guided surgery software. The following protocol will allow you to provide the practitioner or radiologist with the necessary elements to its practice.

The double CT-scan technique provides the dentist with a series of DICOM images of the patient wearing a radiological guide, and another series of the radiological guide alone. The latter with radio-opaque markers on it (this should be done by the clinician) will allow the software to superimpose those two series and will be used as a template to design the surgical guide.



Note: a radiological guide is usually a classic prosthesis with radio-opaque reference points placed on it, or a bite splint made for the occasion.

REQUIRED SETTINGS

The guided surgery software needs « standard » images and will not be able to process images coming from not properly configured scans. That is why it is imperative to follow the configuration described hereafter:

CT SCAN		
Export	DICOM format	Axial images only
Algorithme	Bone ou Bone+	High resolution ok
Matrice	512 x 512	
Slice	0.25 < X < 0.8	Ideally : 0.6
Incrémentation	X < 1	Ideally : 0.3
Gantry tilt	0°	

Note : a continuous mode acquisition is advised for a better reconstruction. Only the axial images are needed, no reconstruction is required.
In case of metallic elements, if possible, choose the artifact reduction option.

For the Cone Beam users, set it to "High resolution" format and artifact reduction.

PROTOCOL

CT-scan of the patient with his radiological guide

• Remove all of the removable metallic elements from the patient's mouth.

• Install the patient and have him bite down cotton rolls placed between the posterior teeth.

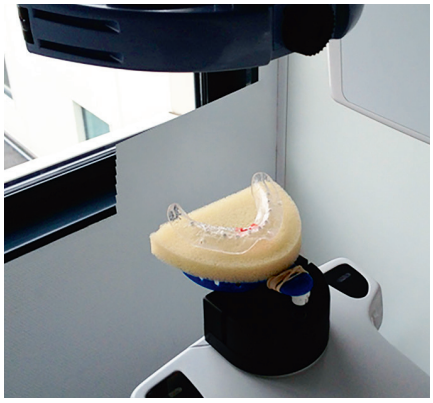
• CT-scan your patient, the area where the radiological guide is.

• Be sure to have a good view and export the data as previously indicated.

Crédit photo : 3Shape®

Note: the occlusion cotton rolls can cause the radiological guide to tip over, especially with toothless patients; in this case, also have them bite down cotton rolls in the anterior region.

Radiological CT-scan



• Place the radiological guide in the same orientation as in the patient's mouth. The right side up for a mandible scan / upside down for a maxilla scan.

• The radiological guide must be put down on a more radio-transparent support than the radiological guide, such as rubber foam, polyethylene or a cardboard support. For a horizontal scan, using a small quantity of adhesive tape is to consider.

• Be sure to have a good field of view and export the data as previously advised.

Note: before exporting the data, make sure that only the guide appears on the obtained slices. Any other element of the scanner will keep the software from being used. The support allows to make the pan disappear, if some peripheral elements appear, reduce the field of view.

ADVICES

• Export the data under the DICOM format without compressing them. The exportation has to be done without a viewer. Most viewers are under license and don't allow to extract source files.

• A successful exportation will give you a file containing all of the images under the .dcm format. This format is not always recognized by Windows; in this case, you will have a series of files without any particular designation or under the "file" format.

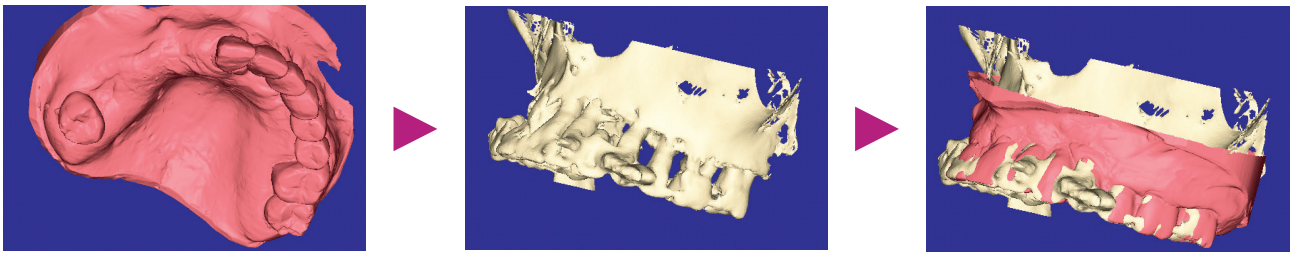
• Only one CT-scan will not be enough to differentiate the prosthesis from the bone of the patient with a filter because the acrylic components of the prosthesis are of a Hounsfield gradient very close to soft tissues.

SIMPLE SCAN PROCEDURE OR TECHNIQUE WITH A PLASTER MODEL

PRINCIPLE

The simple CT-scan technique will allow the dentist to make a radiological guide from a single CT-scan of his patient thanks to a plaster model. It is a substitute to the double CT-scan technique; however, a strict protocol that we will detailed needs to be followed.

The assimilation of the scan of the model in plaster or of the oral scan with respect to the image of the patient is done on the planning software by a repositioning manual step of the supragingival dental elements one to another. This technique will thus only be valid for partially edentulous patients.



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Gantry tilt	0°	

Note : a continuous mode acquisition is recommended for a better reconstruction. Only the axial images are needed, no reconstruction is required.
In case of metallic elements, if possible, choose the artifact reduction option.

For the Cone Beam users, set it to “High resolution” format and artifact reduction.

PREPARATION AND PATIENT SELECTION

As the repositioning of the model is done by analogy, that is to say the assimilation of two similar areas, the patient’s CT-scan must be clearly legible. The patient must therefore have areas with assimilation possibility, that is to say, without artifacts.

Within this framework, we will not be able to obtain satisfying results with the patient that have the following dentures:

- Very few remaining teeth (< 3).
- Remaining teeth only supported by implants (their radiations will make the repositioning difficult).
- Remaining teeth covered with metallic elements.
- Remaining teeth grouped in a same area (unstable guide risk).
- Moving remaining teeth.

Before the CT-scan, be sure to remove all removable metallic parts of the patient’s mouth.

Crédit photo : 3Shape®

Crédit photo : 3Shape®

PROTOCOL

CT-scan of the patient with his radiological guide

- Remove all of the removable metallic elements from the patient's mouth.
- Install the patient and have him bite down cotton rolls placed between the posterior teeth.
- CT-scan your patient.
- Be sure to have a good view and export the data as previously indicated.

Oral scan

- Extract the STL file from your oral scan.

Scan the plaster model (if no oral scan)

The goal of this step is to obtain a STL file corresponding to the plaster model's scan.
To do so, use a CAD/CAM digital scanner.

- Proceed to a complete scan of the model.
- Make sure that there is no shady zone during this step.

USE FOR POST-EXTRACTION SURGERY

The simple CT-scan with a plaster model is often used for post-extraction surgeries for which the teeth extracted previously to placing the guide are filed on the plaster model. This technique is efficient if the previously described prerequisites are respected and that there are enough remaining teeth after extraction.

ADVICES

- Export the data under the DICOM format without compressing them. The exportation has to be done without a viewer. Most viewers are under license and don't allow to extract source files.

- A successful exportation will give you a file containing all of the images under the .dcm format. This format is not always recognized by Windows; in this case, you will have a series of files without any particular designation or under the "file" format.

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