

Dual scan protocol – Standard CT

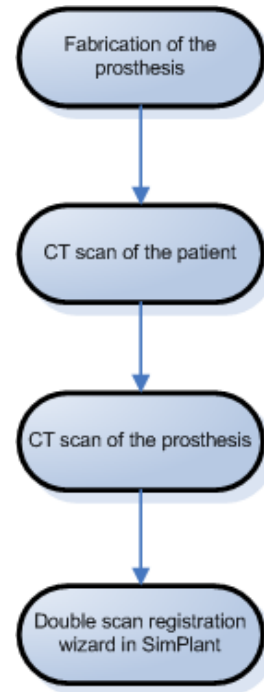
To generate the most accurate mucosa supported SurgiGuide, the prosthesis information should be present in the SimPlant project, together with the patient data. Up until now, this could only be obtained by the fabrication of a radio-opaque scan prosthesis, which is placed in the mouth of the patient during the CT scan.

However, with the latest release of the SimPlant software (version 11), we can now provide a second option to obtain this goal quickly and accurately: the dual scan protocol.

Overview of the procedure

The total dual scan protocol consists of four steps:

1. **Fabrication of the prosthesis:** the prosthesis should be made of an acrylic material, with radio-opaque markers to allow correct positioning according to the patient's anatomy information.
2. **CT scan of the patient:** a CT scan is taken of the patient with the prosthesis in the mouth.
3. **CT scan of the prosthesis:** a CT scan is taken of the prosthesis alone.
4. **Dual scan registration wizard in SimPlant:** a 3D object of the scan prosthesis is generated and registered within the CT images of the patient.



Workflow of the dual scan procedure

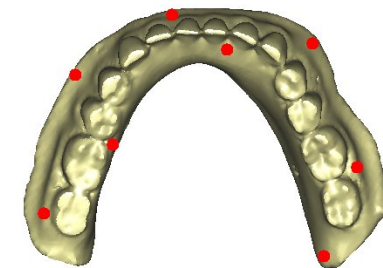
1. Fabrication of the scan prosthesis

The scan prosthesis is made by adding radio-opaque markers to a conventional resin-base removable denture. The denture and the radio-opaque markers should consist of material that causes no scatter. Therefore it is important that the removable denture is made from resin and does not include metallic parts. Preferred materials for the radio-opaque markers are gutta-percha, titanium, or Cavit (3M Espe), which all have a high opacity without causing scatter (when having small dimensions). The markers will be recognized by SimPlant and used to accurately align the prosthesis data with the patient data.

The preferred number of markers is 8 to have optimal results; the minimal number of markers is 4 and the maximal number is 15. The markers should be distributed equally in all directions throughout the complete prosthesis. The number of markers in combination with their location in the prosthesis will influence the accuracy of the match between the patient data and the prosthesis data.

The shape of the markers should be spherical with a diameter of approximately 2 mm.

Remark: If objects causing scatter are present (like remaining teeth with fillings, implants...) the markers in the prosthesis should be positioned so that these appear clearly visible within the CT images and are not in areas where scatter occurs. If this is not possible, these markers will not be automatically recognized within SimPlant.



8 markers distributed over full prosthesis; some markers close to tooth-gingiva border others close to outer border of prosthesis

2.

CT scan of the patient

To obtain images of the patient and the prosthesis together, the patient is scanned while he or she is wearing the prosthesis.

This CT scan will capture information on the patient's jaw and teeth, in combination with prosthesis information – since the prosthesis is present in the patient's mouth. The parameters to use for the CT scan are summarized in part 7: Scan parameters.

2.1 Preparation of the patient

Remove any non-fixed metal dentures or prostheses, in addition to any jewellery that might interfere with the region to be scanned. Non-metal dentures may be worn during the scan.

The scan prosthesis (with the radio-opaque markers) should be worn during the scan, as directed by the dentist or surgeon.

Position the patient supine on the scanner table and move the patient into the gantry, head first.

Make the patient comfortable and instruct him not to move during the procedure. Normal breathing is acceptable, but any other movement, such as tilting and turning the head can cause motion artefacts that compromise the reformatted images, requiring the patient to be rescanned.

2.2

Aligning the patient

For correct alignment, the transaxial CT slice plane should be parallel to the occlusal plane. A gantry tilt of 0° is required. Use the head holder with sponges to stabilise the position. If you cannot orient the head properly in the head holder, use the tabletop. In either case, strap the head securely to prohibit motion.

Stabilize the relationship of the jaws during the scan. The patient is preferably scanned with the jaws slightly open (if available, you can use a bite block). This will reduce the risk of artefacts from the opposing jaw disturbing the images of the jaw of interest. Also, this will make it possible to isolate the occlusal plane from the images.

2.3 Scanning instructions

Mandible

Position the first slice just below the inferior border of the mandible. Position the last slice just above the prosthesis. It is critical you include the entire prosthesis in the scanned study and that no teeth or prosthesis are visible in the last slice.

A typical mandible study contains 80-100 axial images spaced at 0.5 mm intervals. Check the first slice before you continue scanning or use a low dose guide slice. The first slice should not contain any bone from the mandible. If you need to scan lower, start again - do not go back and scan slices after you have scanned above the scan prosthesis.

Maxilla

Position the first slice just below the prosthesis. It is critical you include the entire prosthesis in the scanned study. Position the last slice 4 to 5 mm above the floor of the nasal cavity, unless otherwise instructed by the referring physician. If it concerns zygoma implants, the last slice must be positioned in the middle of the orbita (sutura frontozygomata).

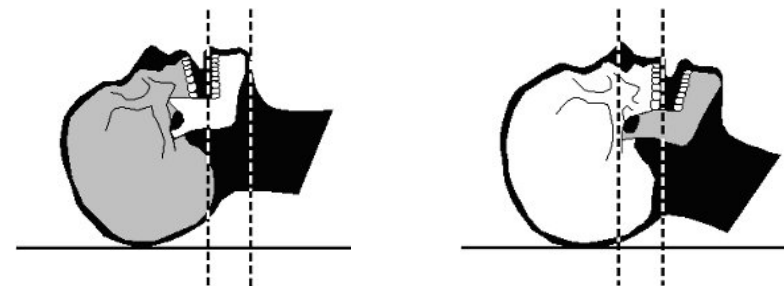
A typical maxilla study contains 60-80 axial images spaced at 0.5 mm intervals. Check the first slice before you continue scanning or use a low dose guide slice. The first slice should not contain any teeth or prostheses. If you need to scan lower, start again - do not go back and scan slices after you have scanned into the nasal cavity.

General scanning instructions

- Set the table height so that the mandible or maxilla is centred in the scan field.
- All slices must have the same field of view, the same reconstruction

center, and the same table height.

- Scanning with a field of view that is too large can compromise the resolution of the reformatted images. Scanning with a field of view that is too small can cause the mandible/maxilla to not fit in all of the axial images.
- Not overlapping the axial slices can reduce the quality of the reformatted images.
- Scan all slices of the study in the same direction.
- Scan with the same slice spacing; the slice spacing must be less than or equal to the slice thickness. The slice thickness should preferably be 0.5 mm, and not be larger than 1.0 mm.
- All of the remaining teeth/scan prosthesis should be completely visible in the images up to the occlusal plane.



Mandible

Maxilla

The dotted lines indicate the position of the axial slices with regards to the patient's anatomy.

3. CT scan of the prosthesis

For the second scan, only the prosthesis is used. The scan parameters are the same as the ones used for the CT scan of the patient (see part 5: Scan parameters).

Take the prosthesis and position it in the CT scanner in the same way that it was positioned in the patient's mouth during the first scan. It is particularly critical that the left-right orientation of the appliance in the second scan matches the left-right orientation of the appliance in the first scan to allow for an automatic and accurate match in the software.

The prosthesis is positioned vertically in the CT scanner. To stabilize the prosthesis in the CT scan, either attach the prosthesis to a block of material as radiolucent as possible or place the prosthesis in between two blocks of material as radiolucent as possible. The material used for positioning the prosthesis must at least be more radiolucent than the prosthesis itself. The more radiolucent this material is, the darker it will appear in the images and the clearer the prosthesis information will be. Polyethylene- and polyurethane-foam materials are a good example of materials that can be used. The prosthesis can be attached to these materials with adhesive tape if necessary.

4.

Reconstruction of the images

- Use a proper image reconstruction algorithm to get sharp reformatted images where you can locate internal structures such as the alveolar nerve. Use the sharpest reconstruction algorithm available, usually described as a bone or high-resolution algorithm.
- Reconstruct the images with a 512x512 matrix and a field of view that includes the entire arch. We recommend a field of view between 14.0 and 17.0 cm.
- Only the axial images are required, no additional reformatting of the images has to be made.
- The images should be saved in the agreed format and onto the agreed medium (optical disk, CD...) as specified in the scan order. Please send the images to the dentist or directly to Materialise Dental or another processing facility to have the data converted into a SimPlant study.

5.

Scan parameters

In conclusion, use the following scan parameters or the closest approximation possible for the scan of the patient wearing the prosthesis:

Matrix	512 x 512
Field of View	Between 140 and 170 mm
Slice thickness	0.5 mm (max. 1.0 mm)
Feed per rotation	1.0 mm
Reconstructed slice increment	0.5 mm (max. 1.0 mm)
Reconstruction algorithm	Bone or high resolution
Gantry tilt	0°

For scanning the prosthesis alone the scan parameters should be at least the same, but a higher resolution is allowed.

SimPlant will be compatible with your data even if you cannot adhere to these settings. Materialise Dental will be able to provide SurgiGuide drill guides in case you use settings that are more strict than the ones above – in the other cases, e.g. when there is a serious reduction of the Field of View or when the inter-slice distance between the images becomes greater than 1.0 mm, the production of a SurgiGuide may be impeded.

For more information,
contact your dealer.

www.materialisedental.com

