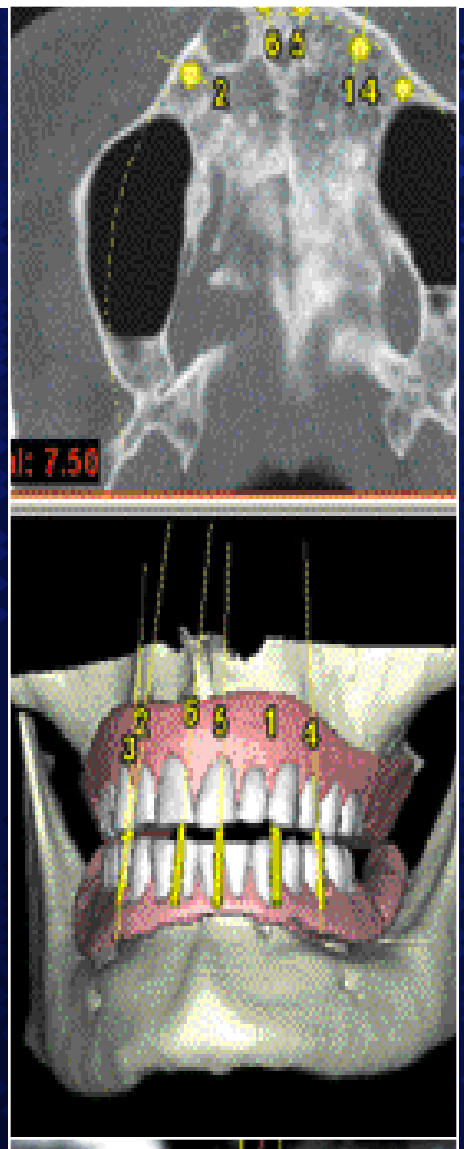
RADIO-OPAQUE



Implantology

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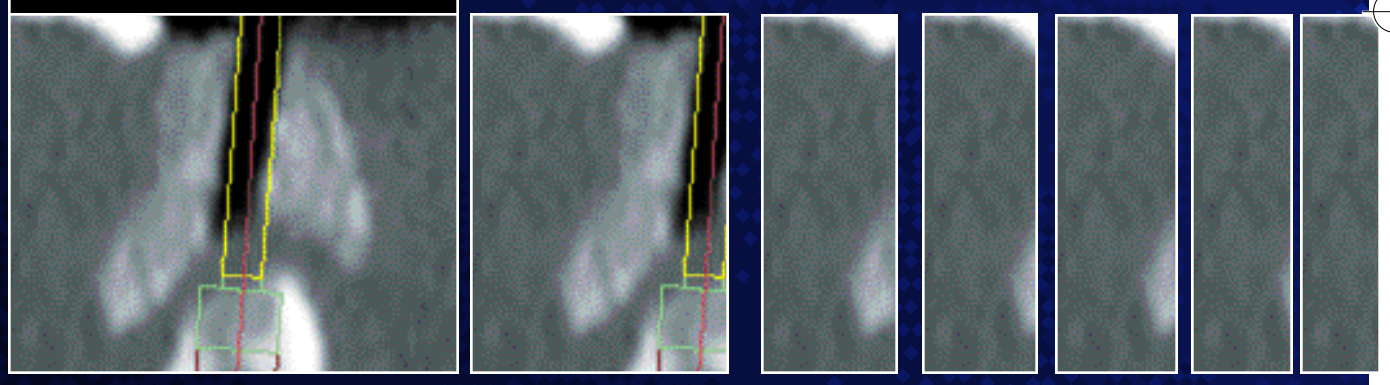
For predictable results:

RADIO-OPAQUE SCANNING STENTS

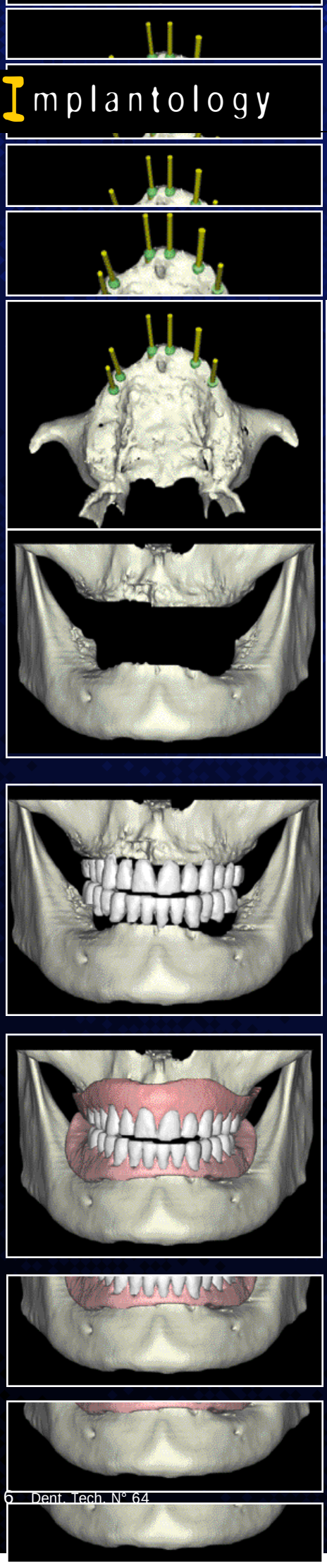


The concept of implant planning using CT scans with radio-opaque surgical guides begins with the state of the patient and their ideal reconstruction. This article describes the laboratory procedures for fabricating a radio-opaque scanning guide, or stent, to act as a marker in the mouth when used in conjunction with guided implant surgery planning software.

The technician fabricates a mock up of the ideal build up according to the individual parameters of the patient such as occlusion, virtual dimension etc. During the CT scan this will enable the visualisation of the ideal axes in relation to the bone structure, and therefore help determine the most adequate place for implant positioning.

RADIO-OPAQUE

Implantology



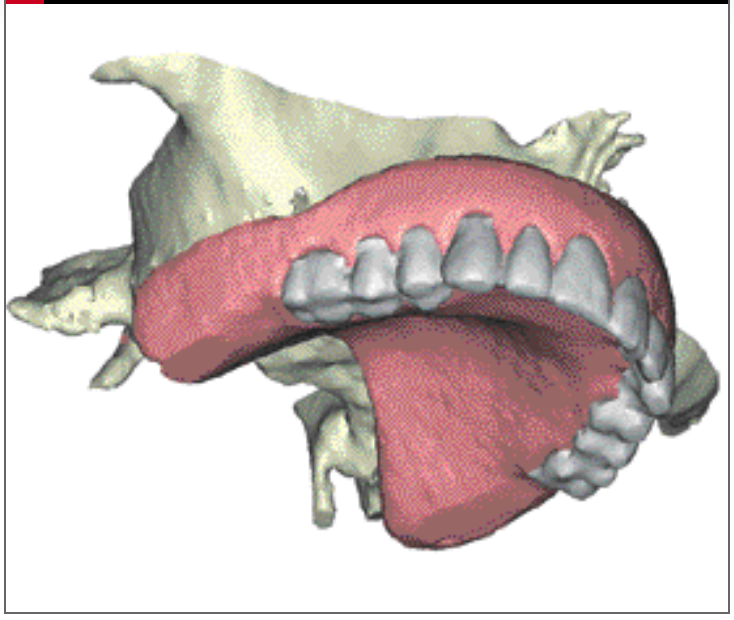
PLANNING SYSTEMS FOR BOTH SURGERIES AND LABORATORIES

Last year, for the first time we introduced the new capacities of virtual planning for implant treatment via the use of CT scans and implant planning software.

This was just the tip of what is emerging as a revolutionary iceberg, bringing advancement in the way that implant cases are approached and the predictability of results that can be obtained. A number of CT scanners and Software Planning Systems are now available to be used in both dental surgeries and laboratories.

1 *Radio-opaque teeth (SR Vivo Tac / SR Ortho TAC) from Ivoclar-Vivadent Ltd.*

2 *Scanning stent visualised using SimPlant software.*



PROTOCOLS FOR RADIO-OPAQUE STENTS

The process of making stents using thermoforms or acrylic is very familiar to both dentists and dental technicians. Plastic and clear acrylic do not show up well on a CT scan. To make them show up, you must mix barium sulphate with the acrylic, paint barium sulphate on the surface, use radio-opaque teeth, or use markers made from a radio-opaque material such as lab putty or gutta percha.

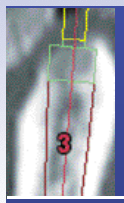
In this article we recommend using the packing method with radio-opaque teeth (fig. 1) and a barium sulphate-acrylic mix for the baseplate. This will aid planning by producing images with a clear distinction between the neck of the tooth and the baseplate. By using a packing method the distortion of the fitting surface can be limited. An accurately fitting scanning stent is essential for mucosa-supported surgical guides.

ANTICIPATE THE FINAL RESULT

The best way to make a stent is to start with a new diagnostic set-up or wax-up. This means that the entire process can be restoration driven because all decisions can be based on the anticipated final result. There are different ways to make a scanning stent and it is up to you which method you prefer: the method described below gives very good results. The most important thing is that the fitting surface is accurate and that the patient can seat it accurately with ease (fig. 2).

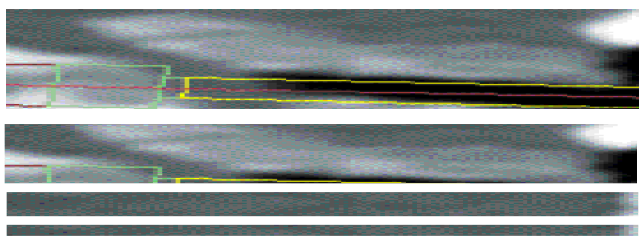
PROCESSING STEPS

- When you get the try-in back, extend the flanges as far as possible and ensure you have adequate palatal coverage. The bigger the flange, the better the stability of the subsequent drill guide.
- Seal the wax to the model.
- Flask the model and the set-up with the radio-opaque teeth as you would for a denture.
- Paint the flasks with a separating medium.
- Mix 10% by weight of barium sulphate with the desired amount of cold cure clear acrylic for the baseplate. The barium sulphate will act as an accelerant, so keep the mixture more runny than normal to increase the working time. It is best to first put the monomer in and then mix in the polymer and barium sulphate. If you see that the barium sulphate powder is making little lumps, do not use the mix. Too much barium sulphate will create artefact, and can destroy some bone information in the CT scan. An inadequate mix will not show up properly in the CT scan. Only use barium sulphate powder, not the granular version.

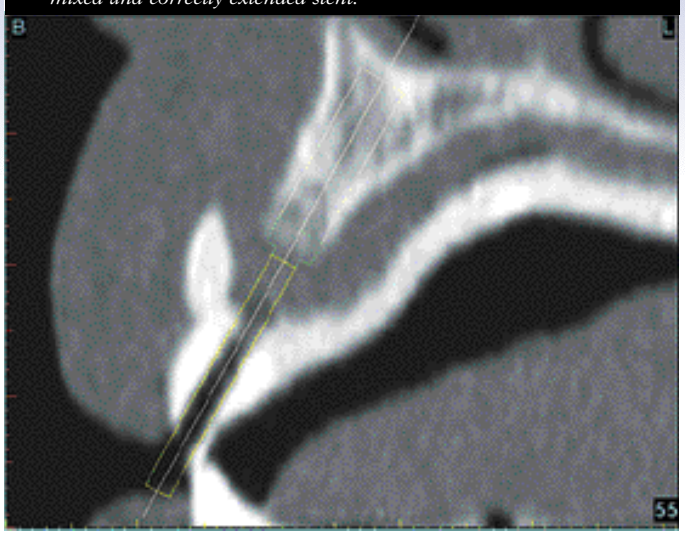


Instructions for dentists

- Take impressions of the edentulous or partly edentulous area. If the patient has a removable appliance with teeth in a desired position, take an alginate of this in position for reference. If you want the stent to be an exact copy of the denture, you can do a pick-up impression or make a putty index of the denture (see box “Copy dentures as stents”)
- Articulate the study casts and make a diagnostic setup that reinstates the missing dentition and soft tissue. Verify occlusion and vertical dimension on the articulator.
- You can cut away baseplate wax on the buccal aspect. Try to mimic the final result so that the patient can get an idea of what it will look like (length of teeth, height of gingival margin, midline, lip-support). Ensure that the try-in is still stable enough. If the final case will be an overdenture, leave the buccal flange.
- Try-in the set-up to evaluate functional, phonetic and aesthetic aspects. Having the buccal flange cut away will reveal pitfalls and can demonstrate the final result better. Remember to add the flange again before processing!
- Return to lab with instructions on what type of scanning stent you want. Stress the importance of maximum flange extensions and accurate fitting surfaces to the technician.
- When you get the scanning stent back, verify the fit. If the opposing arch has metal restorations, add two self-cure acrylic stops in the posterior region on the stent. This will open the bite and therefore avoid artefact in the CT images.
- Instruct your patient to take the stent to the CT scanning site, to wear the stent during the CT scan, and to keep completely still during the CT scan.



3 *Implant lined up with dark tunnel during planning; notice the well mixed and correctly extended stent.*



- Pack the flask and let it harden in the press for 30 minutes.
- Trim, do the bite, and polish.
- Determine where ideal implant positions should be. Drill holes through the stent in the ideal positions. These holes will show up as air and therefore as dark tunnels on the CT scan. When placing implants in the software, the implants can be aligned to these hollow areas. If the case is not completely edentulous, take the angle and position of remaining teeth and roots into account (fig 3).

VARIATIONS

1. Using a pressure pot

Processing in a pressure pot as you would for a temp will also work, but make sure that the baseplate does not warp. An ill-fitting stent will result in an ill-fitting mucosa-supported surgical guide. Packing is definitely the preferred method.

2. Self-mix teeth

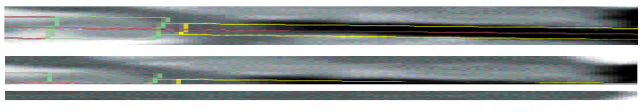
If you do not want to use radio-opaque teeth, you can use ordinary teeth for the setup, but you cannot process with them. You can try a packing method where you first cure the baseplate acrylic separately. This is done by placing a plastic sheet over the teeth in the flask and then curing with the plastic in place, like trial packing. You then have to remove the teeth from the flasked mould. This is difficult to do because plaster bits will break off. Make a new mixture with a higher percentage of barium sulphate for the teeth. This will make the teeth show up with a higher density than the base in the CT images. For teeth, a mixture of 15% by weight of barium sulphate should be used. Try not to overpack and avoid getting a flash of the higher percentage mix on the baseplate.

Copy dentures as stents

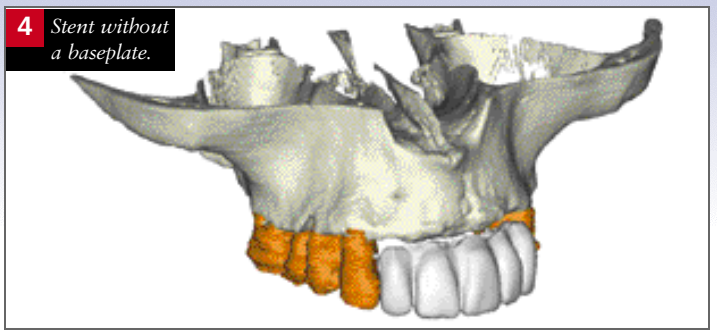
If the patient has a well fitting existing denture and the denture tooth positions are suitable for implants, a copy stent can be made. The problem with an alginate impression of the denture is that if a putty index is made from this, it is difficult to position the index correctly on a model without having the denture in place. By making a matrix of the entire denture, the lab can obtain the required information quickly, so that the patient is not without the denture for too long.

- Mix lab putty and press it into the fitting surface and cover about 2mm of the flanges all around. Be careful not to get folds or air holes in the mix on the fitting surface.
- Cut the lab putty around the flange straight about 2mm above the flange end.
- Cut 5 index triangles into this straight surface.
- Put a separating medium on the lab putty and make the second part of the matrix by mixing lab putty and covering the rest of the denture. Use a lot of putty to ensure it is strong and stable.
- Remove the lab putty placed over the denture, and from the inside of the denture. Check that the putty information is accurate.
- Check that the two halves slot together accurately. The matrix must not be flexible in any way.
- Cut two holes in the posterior area of your matrix.
- Pour molten wax into the matrix and let it harden. Pouring acrylic in the matrix will not result in a stable, well fitting scanning stent!
- Fit the wax copy of the denture on a plaster model and process as described.

Alternatively the dentist can take a pick-up impression of the denture. The lab can make a model and then make a lab putty index of the denture on the model. The denture can be removed and acrylic can be poured into the matrix to make a stent. This will only work if you have a denture with an accurate fitting surface. If not, you will have to first make a wax copy in the matrix and then fit the wax copy on a model that accurately represents the fitting surface.

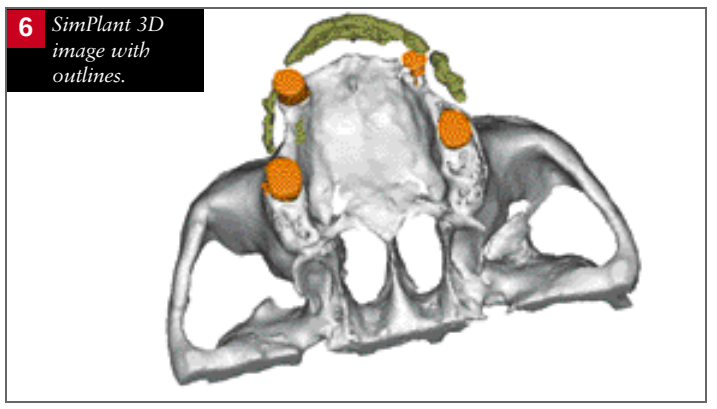


4 *Stent without a baseplate.*



5 *Outline of painted tooth in cross-sectional image.*

6 *SimPlant 3D image with outlines.*



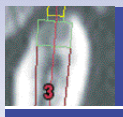
3. Bone-supported surgical guides

In cases where you will DEFINITELY not need a mucosa-supported surgical guide, you can use clear acrylic for the baseplate and the barium sulphate acrylic mix just for the teeth (fig 4).

Alternatively you can make the entire stent in clear acrylic and just paint the outside surfaces of the teeth with a barium sulphate mix. Mix the barium sulphate with die hardener and paint over the entire tooth area of the stent or existing denture (fig. 5).

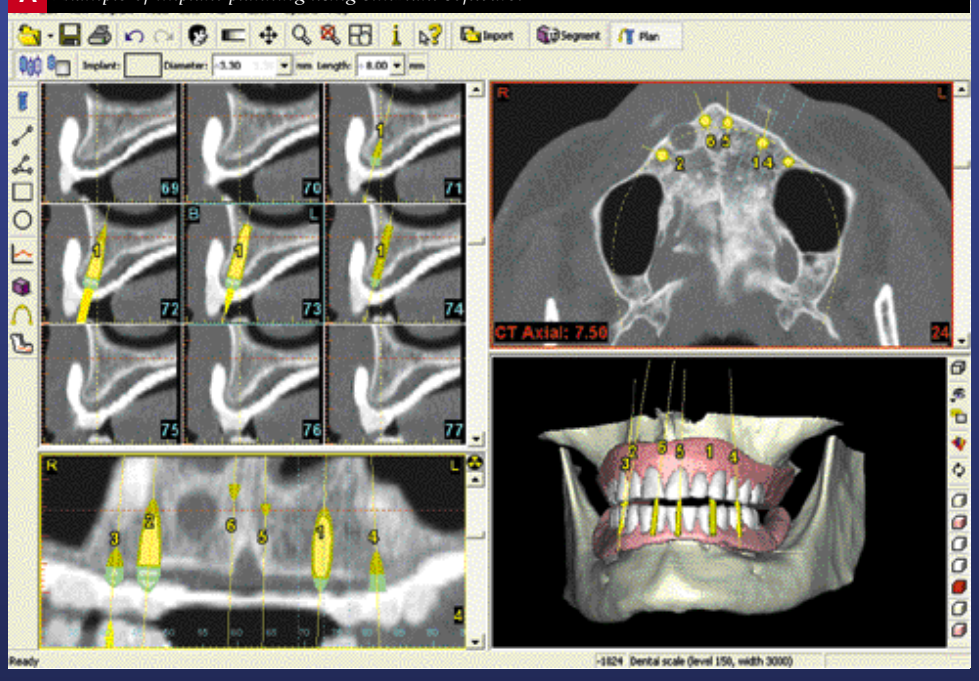
This will make the teeth show up as hollow shells in the image to assist you with the planning. If you use stents without baseplates, you will not be able to order a mucosa-supported surgical guide (fig. 6).

If you are unsure about which type of surgical guide will be needed, always make the baseplate with radio-opaque material and always extend the flanges as far as possible.



Advantages of using a radio-opaque stent

A *Example of implant planning using SimPlant software.*



If a patient wears a radio-opaque stent while being CT scanned, it significantly increases the clinical value of having a CT scan and reformatting the CT images for implant planning software such as SimPlant (by Materialise) (fig. A). The implant process can then be completely "restoration driven" from planning to placement.

THE ADVANTAGES OF USING A RADIO-OPAQUE SCANNING STENT INCLUDE:

1. The desired position and size of the final restoration can be visualised in the 3D image and the axial-, sagittal- and coronal planes. The virtual implant can be lined up with the desired position as outlined by the stent or by radio-opaque markers placed in the stent.

2. Implants can be planned in accordance with clinical and aesthetic requirements. Implant depth, position and angulation can be manipulated to correspond with the desired emergence profile of the restoration, or in screw-retained cases, the position of the screw hole. The proximity of the virtual implants to other anatomical structures can be clearly seen.

3. They give an overview of the treatment plan allowing you to see if bone augmentation, bone grafts or sinus lifts are needed. The desired angle of abutments can be determined, and by using the Hounsfield Unit (HU) measure of bone density around the implants, the bone quality and hence the total number of implants needed can be assessed from the Misch Bone Density Classification (fig. B).

4. The possibility of ordering implants and the sequence of drills required prior to surgery allows for better stock control.

B MISCH BONE DENSITY CLASSIFICATION[2]

D1	>1250 HU	Dense cortical bone
D2	850-1250 HU	Thick dense to porous cortical bone on crest and coarse trabecular bone within
D3	350-850 HU	Thin porous cortical bone on crest and fine trabecular bone within
D4	150-350 HU	Fine trabecular bone
D5	<150 HU	Immature, non-mineralized bone

5. Visualisation of the anticipated result by the patient during the try-in stage. The type of restoration (fixed or removable) and the aesthetic implications and limitations thereof can be discussed with the patient. Vertical dimension, lip support and function can be evaluated before any implants are planned.

6. Provision, by the stent, of inter-arch stability for the patient during the scan. If the maxilla and mandible are scanned together, the 3D image will illustrate the vertical dimension and arch relation.

7. The option of the scanning stent to act as a conventional acrylic drill template or guide in cases where an automatically fabricated surgical drill guide, or guiding cylinders (such as a SurgiGuide, from Materialise) is not going to be used.

7 *Thermoform with registration markers.*

STENTS WITH REGISTRATION MARKERS

Registration markers can be added to any kind of stent. The purpose of these markers is to ensure that a computerised 3D model of the stent can be registered into the same co-ordinate system as that of the CT scan. If you are not going to make a diagnostic stent with implant markers, you can just make a suck-down thermoform with registration markers (fig. 7).

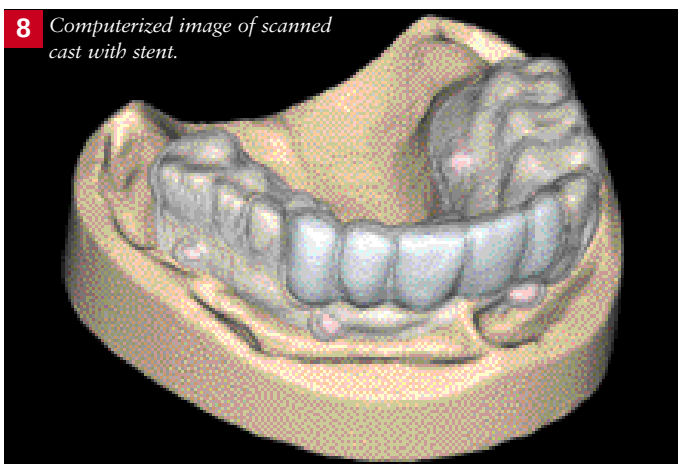
PLACEMENT:

Markers should be placed in the flanges of the stent, beyond the gingival level of the existing teeth. This way the markers are away from the level at which any artefact is likely to occur. About six or seven spherical markers of about 2mm in diameter are required. Place one marker in the buccal flanges on each side in the molar region, another two in the lateral incisor area, and three in a tripod spacing in the palate of the maxilla. For the mandible, add three markers below the gingival level in the lingual flange.

MATERIAL:

Use any radio-opaque material. You can use mixed barium sulphate (in a higher percentage than any that has been used for the baseplate), or lab putty, gutta percha, or a radio-opaque composite.

If the patient will wear the thermoform with markers as a scanning stent, you must block out all of the undercuts of the teeth. Otherwise the patient will not be able to get the thermoform on and off! Make sure that the markers are fixed securely, otherwise they will fall out if the thermoform flexes during placement (fig. 8).



8 *Computerized image of scanned cast with stent.*

THE SCANNING STENT AND THE CAST SHOULD BE KEPT TOGETHER.

This way the stent and cast can be laser scanned at the same time, and the markers can be used to relate the model data to the scan data.

CONCLUSION:

In this article I have discussed implant planning using CT scans, and the fabrication procedure for radio-opaque scanning stents.

Nest month I will discuss some of the systems currently being used in dental laboratories, and how they have adapted their businesses to maintain their position as an integral part of this technology. ◆

Foot Notes: Address

(1) **Smile Profile Ltd: 44 Herschel Court, Claremont, South Africa 7708.**

(2) **Misch C.E. Contemporary Implant Dentistry (Second Edition). St. Louis: Mosby, Inc. 1999. ISBN 0-8151-7059-9.**

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