

Use of an X-ray phantom in dental 3-D diagnostics in digital volume tomographs

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Introduction

Undoubtedly, digital volume tomography has significantly expanded the range of dental imaging diagnostics. Just as Paatero succeeded in ushering in a new era of dental radiology at the end of the 1950s with the development of an orthopantomograph and the resulting introduction of panoramic view imaging, three-dimensional processes will, in turn, replace panoramic view imaging.

Although digital volume tomography has to date been mostly used for preimplantological planning and in reconstruction surgery, now other dental disciplines are beginning to appreciate and use the high value of this process – it is in orthodontia, endodontia, dental surgery as well as periodontics that digital volume tomography represents a significant improvement of the possibilities of imaging processes. Sometimes their significance can even be assessed as being greater than in the current domain, preimplantological diagnostics.

Fig. 1a and 1b_ DVT phantom ("maxillary sinus floor" and "nervus alveolaris mandibulae" are simulated with radiopaque wire structures).

Volume—available volume tomographs

After digital volume tomographs had been on the market for a good decade, the number of suppliers of such devices increased dramatically – and the number is still increasing. When observing the device market, two clear trends can be seen:

- a) The trend towards an "all-in-one device" (also called "dual use")
- b) The trend of offering various volumes

All-in-one-devices ("dual use")

In addition to offering 3-D diagnostics, the majority of digital volume tomographs available on the market also provide the option of producing panoramic view images ("real" images, not reconstructed from a data record) and sometimes even an FRS image.

These devices thus cover the entire range of dental "large-scale diagnostics" – in contrast to the first generation, which only gave the DVT option.



Fig. 1a

Fig. 1b

The DVT devices of today's generation are often similar in design and appearance to traditional digital volume tomographs; the position of the patient with these and other "frame" devices is typically standing or sitting, while the once dominant supine patient position of the first device generation is passé except for one manufacturer.

Various volumes

Such first-generation devices featured very large volumes which required time-consuming reworking of the immense data record for problems beyond large and reconstruction surgery in order to be able to evaluate the "relevant" data and/or regions in a target-oriented manner. Today numerous manufacturers offer devices with mid-size and small volumes. Three types of devices are available:

- Devices with a large volume (18 x 20 cm and higher) for oral surgery and reconstruction.
- Devices with a medium volume (8 x 10 cm and higher) for oral surgery and reconstruction.
- Devices with a small volume (4 x 5 cm) for oral surgery and dental procedures.

Problems with devices with small and medium volume

Devices with small and medium volume are generally used in oral surgery and dental practices; they are mostly used for preimplantological diagnostics, for oral surgery and orthodontic and endodontic procedures.

The "finiteness" of the volume size requires careful device setting and patient positioning so that the relevant structure is also depicted and/or "encountered"; it must also be "well targeted."

For new users and those colleagues who only do volume tomographies once in a while, this correct setting can pose difficulties.

This was our motivation to develop a DVT phantom which can be used for training purposes as well as for direct preparation of an image with a patient.

The DVT phantom and its application

The DVT phantom is an X-ray phantom which depicts a medium-sized mandibular and maxillary dental arch; the teeth are positioned in ideal denticulation.

The divided phantom (mandible and maxilla) is mounted on the individual biting or positioning aid/support of the respective device. Barium sulfate is added to the plastic teeth so that they are visible in

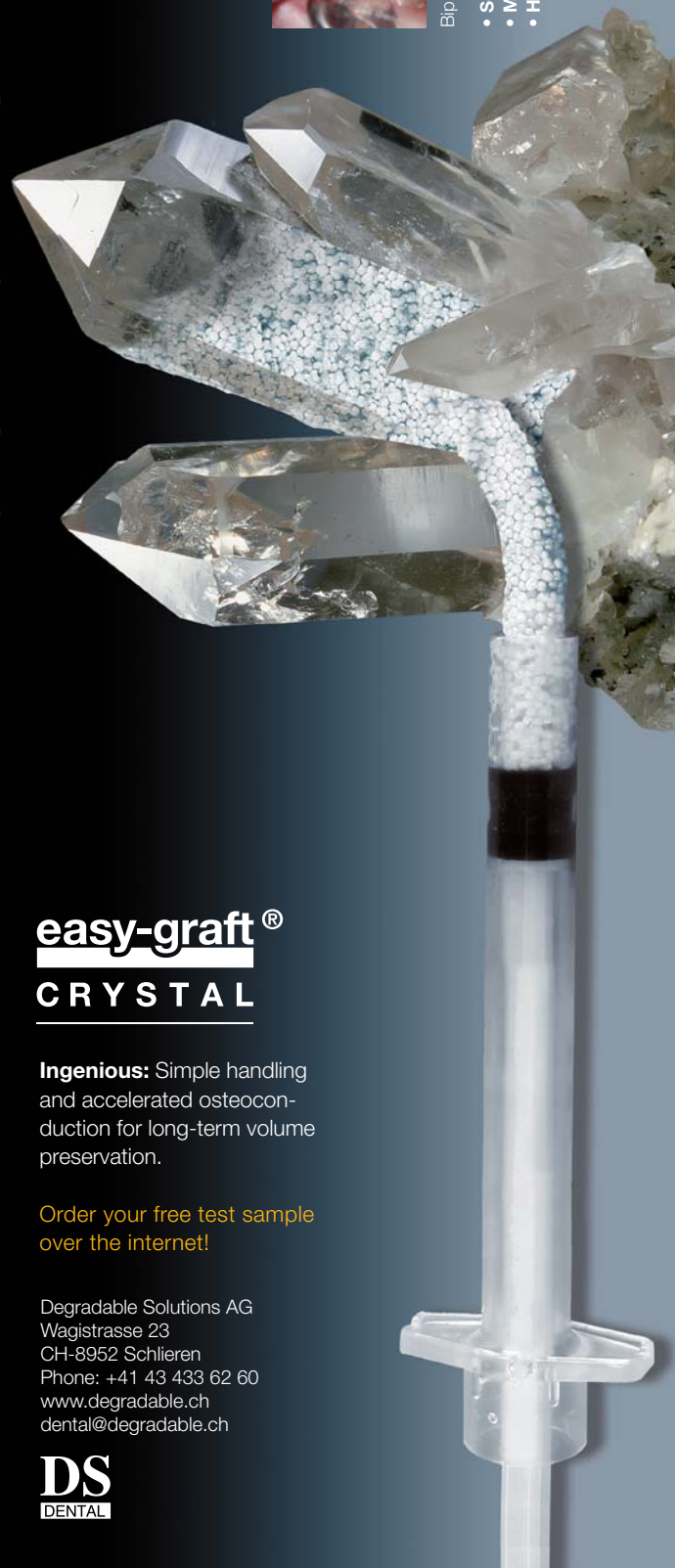
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Fig. 2_ DVT phantom in a volume tomograph (Kodak 9000 3d, small volume) fixated on the original patient biting aid.

Fig. 3_ Device settings: With the aid of the light visors, a volume is placed on the region to be depicted (here region 26 and maxillary sinus floor).

Fig. 4_ DVT phantom image of the maxilla with the X-ray phantom.

Fig. 5_ DVT phantom image of the mandible with the X-ray phantom.



Fig. 2

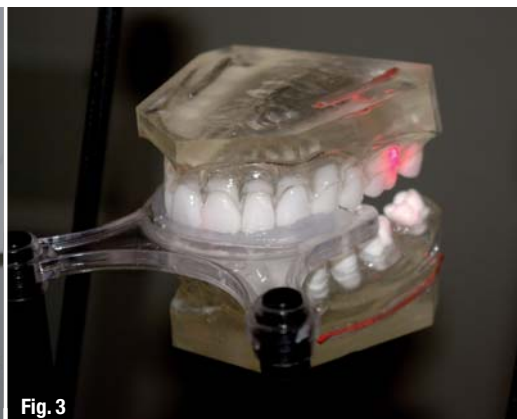


Fig. 3

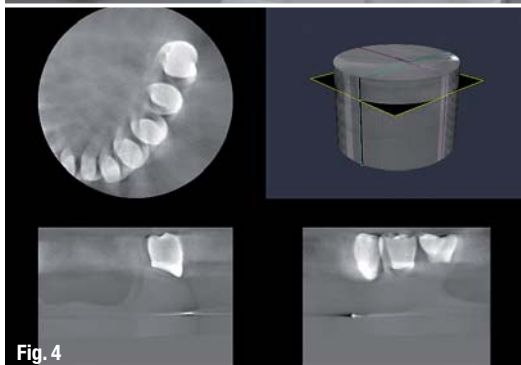


Fig. 4

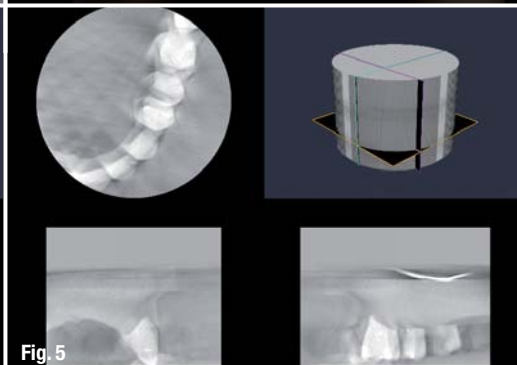


Fig. 5

the X-ray image; these teeth have been made by the manufacturer especially for X-ray applications.

The DVT platform is now mounted in the device with the original biting aid/support instead of a patient. The device setting can occur in two different ways:

- a) The desired volume is preset using the device program and then manually fine-tuned.
- b) The device is manually set directly on the region to be depicted with the aid of the light visors. Then the set positioning is saved.

Using the DVT phantom for training and practice purposes

With the aid of the DVT phantom and the above-mentioned setting techniques, new users or colleagues seeking technical qualifications can learn how to set the device for the regions to be examined, generate one or more individual images using the "preview function" and check to see if the setting was correct. In the event of incorrect settings, a better image can be immediately generated so that there is a direct learning curve.

Using the DVT phantom for preparing a patient image

Time-consuming and tedious setting ("aiming") of the volume on a patient who is already in the device is not something that will generally meet with

the patient's whole-hearted agreement. This is where presetting the device with the aid of the DVT phantom comes in handy. The desired region is depicted with the phantom and, if needed, is checked with the preview function. Then the phantom is removed, and the patient is fetched and positioned in the device. Generally, only one device setting for the patient's body size and small fine-tuning are required and the image is set.

How to obtain a DVT phantom

Such a DVT phantom can be produced in cooperation with practicing dental technicians, the barium sulfate-containing plastic teeth are available on the market and a phantom can be made in the manner described above. An easier option is to send a DVT positioning aid of your device to www.dtcmfreiburg.de or dtecmfreiburg@aol.com. Master Dental Technician Christian Müller will then mount a prepared DVT phantom on your positioning aid. Industrially manufactured barium-sulfate-containing plastic teeth (SR Vivo Tac/SR Ortho Tac, Ivoclar Vivadent) will be used which are then incorporated into a mandibular and maxillar model made of transparent plastic.

The authors of this article hope that the fascinating field of 3-D diagnostics will establish itself quickly in dentistry and that it will remain an imaging procedure that significantly expands upon the hitherto range of dental X-ray diagnostics in the long term.

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