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EVAR-3D Guidance: A new live 3D endovascular guidance system

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Illustrated Workflows in Hybrid Operating Rooms, No.5

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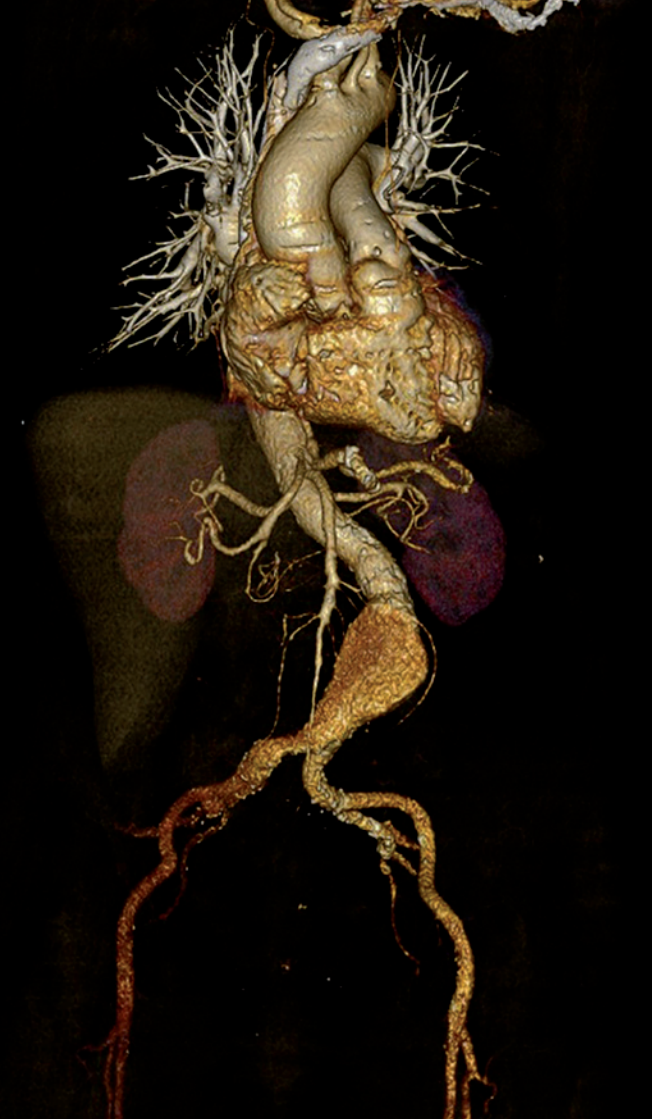
Department for Cardiovascular and Thoracic Surgery at OLV Hospital Aalst

Dr. Lieven Maene

At its three campuses in Aalst, Asse, and Ninove, the Onze-Lieve-Vrouw (OLV) hospital has been investing continuously in new techniques and equipment and in training and education to ensure the best quality of service. The department of cardiovascular and thoracic surgery was founded in 1980 and performs about 900 heart surgeries, 1100 vascular surgeries, and 180 lung surgeries each year.

Since 1995, progressive techniques have been implemented for various cardiac surgical procedures with and without the heart-lung machine, such as the use of robots for bypass surgery, laparoscopic surgery for valve and heart rhythm surgery, and transaortic valve implantation. The same applies to vascular surgery, where currently almost 75% of surgeries are performed with an endovascular approach.

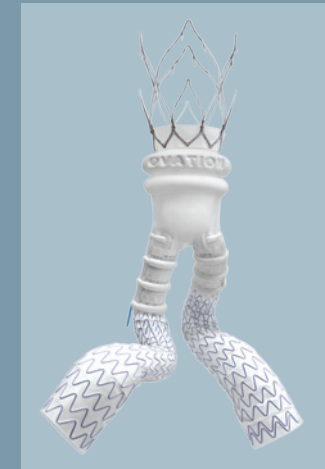
In 2009 a new building on Campus Aalst was finished including a new hybrid operating room.



Clinical case

The 87-year-old female patient presents with an asymptomatic infrarenal aortic aneurysm of 52mm (2 in) in diameter. An exclusion of the aneurysm with an Ovation stentgraft by TriVascular was planned.

The pre-operative CT image is shown on the left.



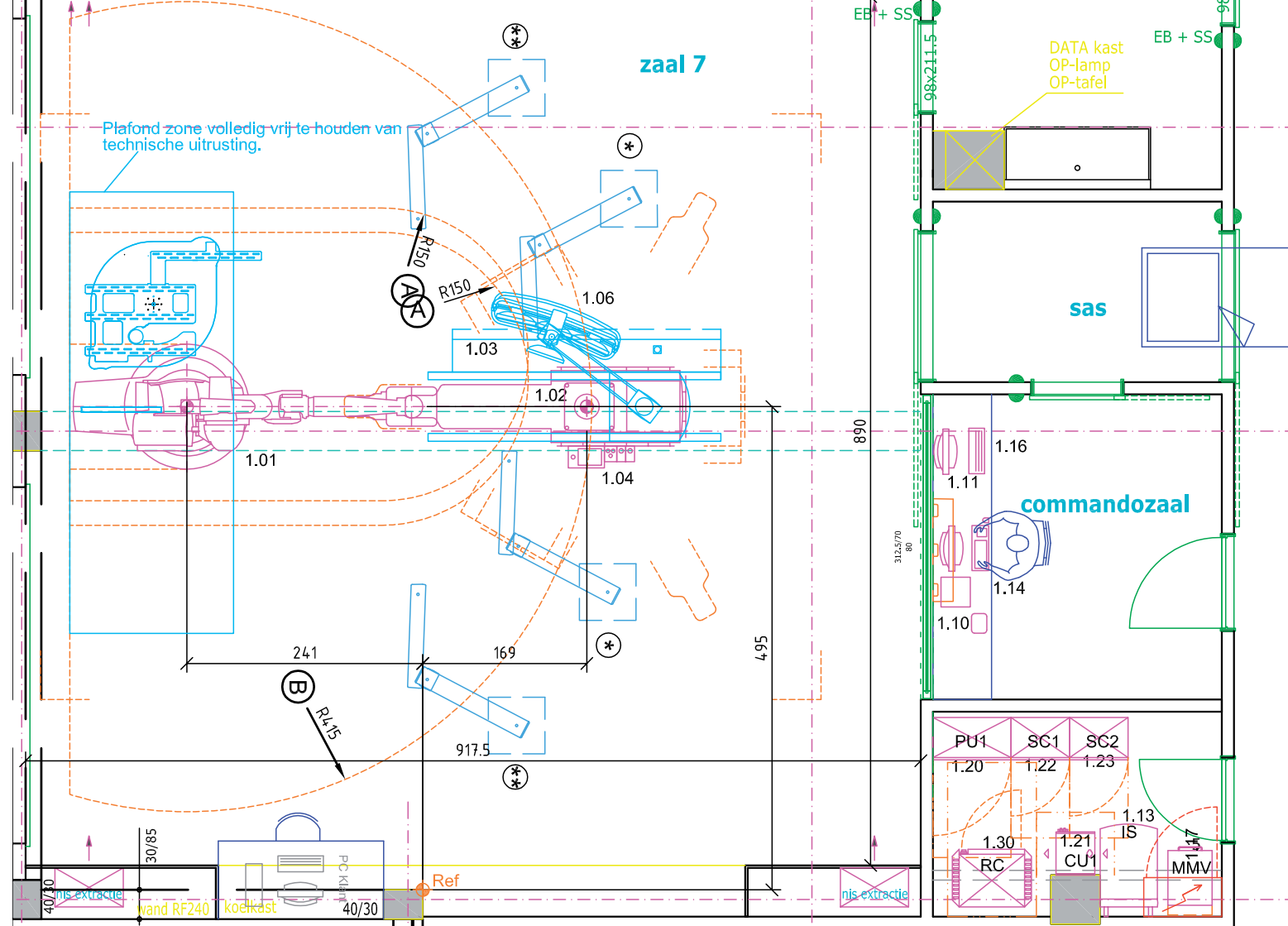
Ovation© graft courtesy of TriVascular

The Hybrid Operating Room

The hybrid operating room at the OLV hospital in Aalst is equipped with the newest robot-supported imaging system, Artis zeego. The robot is installed in-line with the OR table, which is called a zero degree installation.

The room size is about 83 m² (883 ft²) excluding the control room. The room itself accommodates four Dräger Movita ceiling supply units, two OR lamps by Maquet (not shown in the plan on the right), the Artis OR table, and a range of storage shelves. Six monitors are installed on a Display Ceiling Suspension (DCS) above the OR table.

The anesthesia equipment is placed on a trolley at the head end of the table, providing substantial space to freely access the patient as shown in the picture.



Preparation

Sterile sheets are tightly wrapped around the patient to ensure maximal sterility when the C-arm rotates around the patient.

The OR table is rotated 15 degrees with respect to Artis zeego, which provides more space for the anesthesiologist and more flexibility to move the C-arm into the surgical field than a table rotation pointing straight to the Artis zeego stand. In particular, the table rotation eases the 3D image acquisition. The robot adapts automatically to the table rotation and aligns the detector as well as the collimator along the table for an upright image.

OR lamps can stay in place when Artis zeego moves into the surgical field as illustrated in the picture on the right.



Placement of the catheter

In general, stiff catheters deform the iliac arteries and the aorta when advanced into the aorta. Thus, the anatomy in preoperative images might not exactly match the intra-operative situation. Therefore, information derived from pre-operative images or images acquired before the catheters are inserted might not meet the accuracy required for precise 3D guidance.

In contrast, in this workflow the catheter with the endograft is inserted in the aorta (but not released) before the actual 3D *syngo DynaCT* acquisition. By acquiring the 3D image after inserting the catheter, the deformations are captured in the 3D image and the final overlay of the 3D image matches the live fluoroscopy with minimal distortions.



3D *syngo* DynaCT acquisition

The *syngo* DynaCT is acquired with the catheter in place.

A five-second digital subtraction angiography (DSA) protocol with undiluted 6 ml contrast agent injection per second is chosen. The integrated contrast injector delays the image acquisition by one second, which results in total contrast usage of 36 ml for the 3D image. The image is analyzed at the 3D workstation in the control room (see image at left).

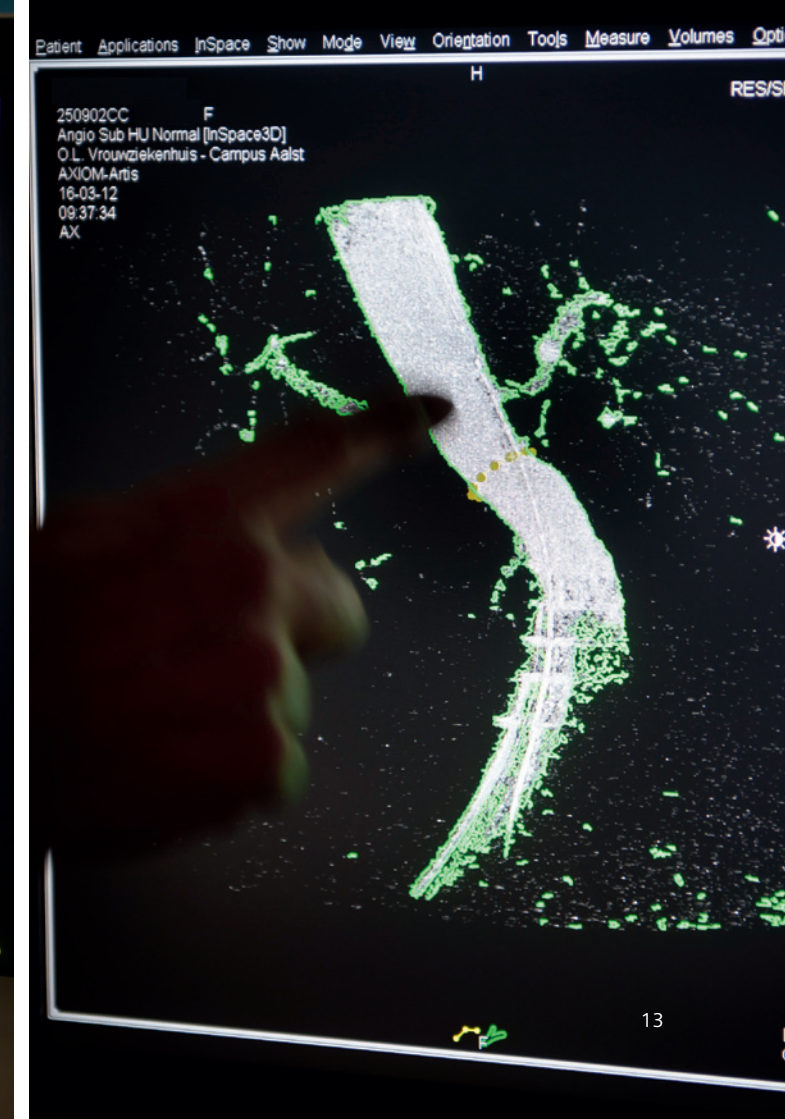
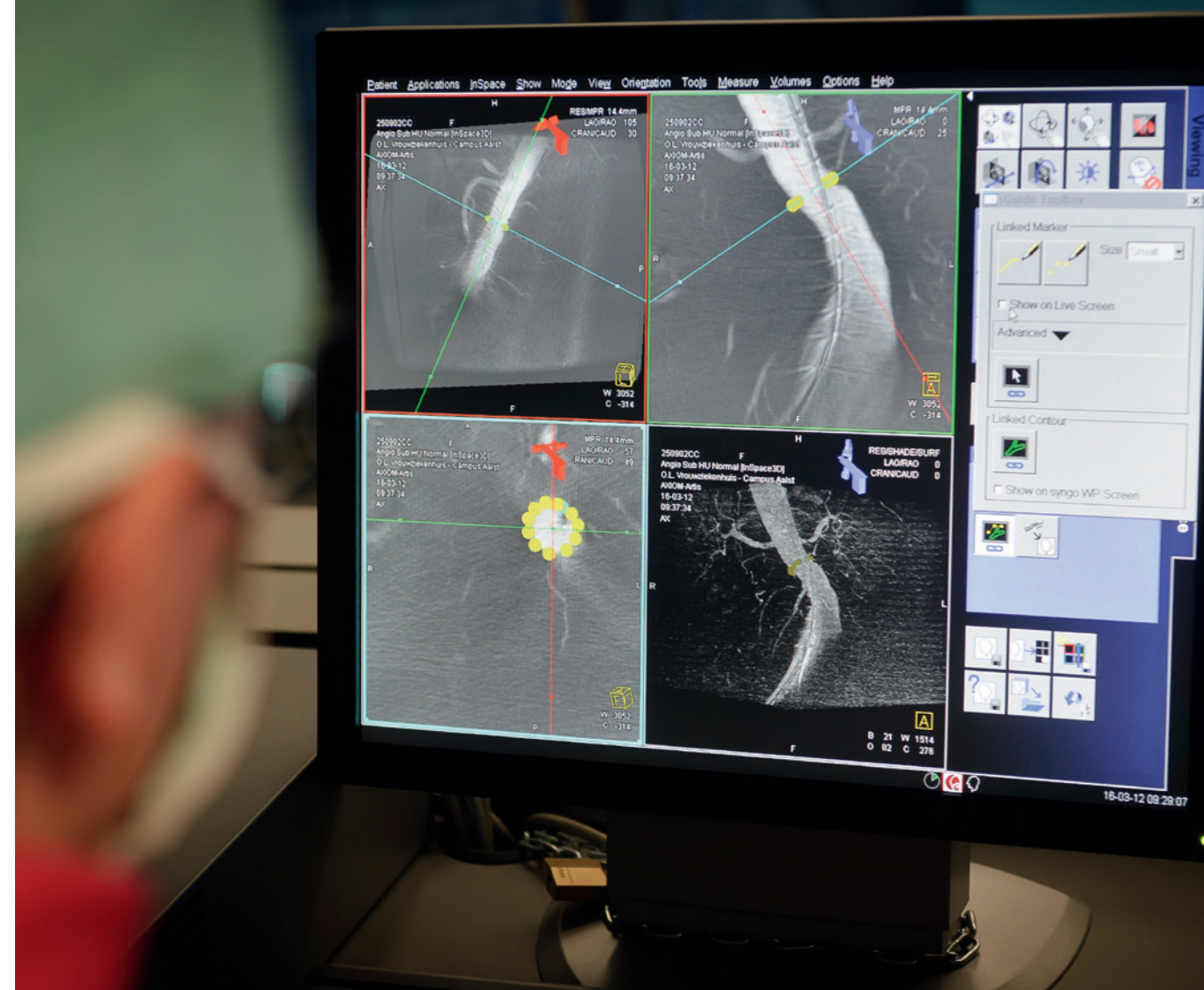


3D planning at the workstation

The workstation displays the 3D image in three orthogonal slices as well as a 3D volume rendering in the lower right window (see left image). The cross in the upper left and upper right window is rotated in such a way that it is aligned with the center line of the aorta, i.e. the plane in the lower left windows is perpendicular to the aorta. A guidance ring displayed as yellow dots is interactively drawn by the user around the aorta in the lower left window using the syngo iGuide Toolbox. The three dimensional ring is simultaneously shown in the other planes and in the volume rendering in the lower right window. Since the plane in the lower left window is perpendicular to the center line of the aorta, the ring is perpendicular as well.

The position of the ring along the aorta was chosen in such a way that the ring represents the desired position of fluoroscopic markers at the Ovation graft. Later in the OR, the graft is placed so that the markers match the ring exactly.

The automatic outlining is switched on (right picture), which provides additional information about the anatomy, including the position of the renal arteries.



EVAR-3D Guidance for optimized fluoroscopic angulation

The three-dimensional plan prepared at the workstation is automatically overlaid on top of the fluoroscopy images. It includes the aorta outline and the manually-drawn guidance ring (see red arrow). The three-dimensional overlay is linked with the C-arm, i.e. the workstation recognizes any movement of the C-arm and recalculates the overlay accordingly.

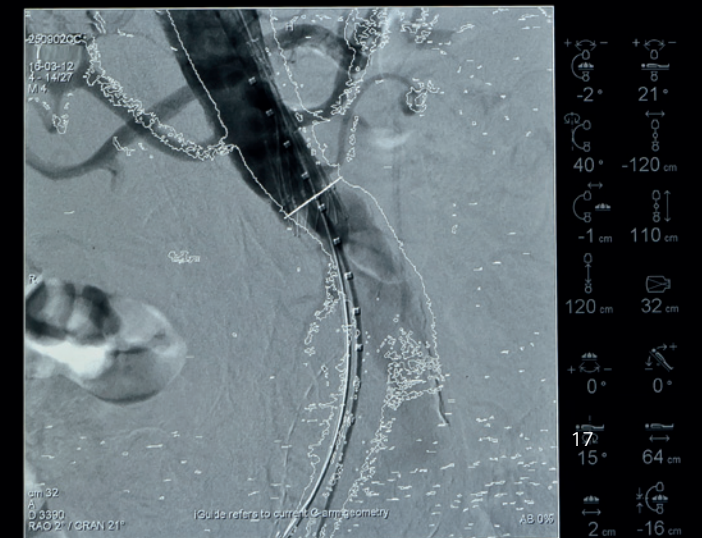
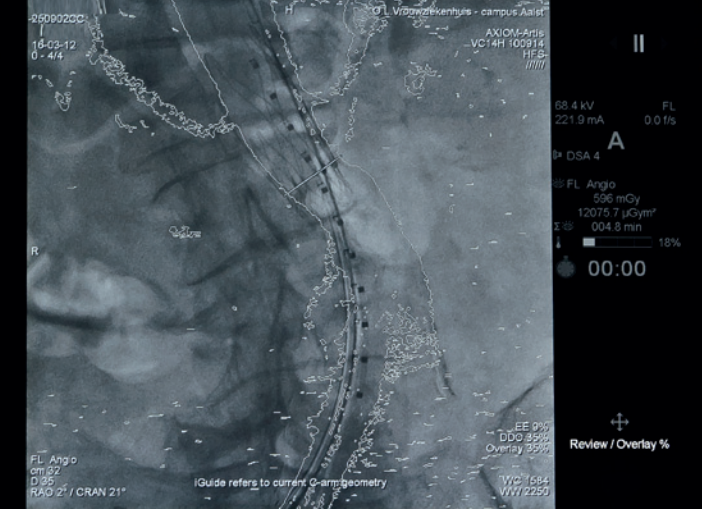
With an anterior-posterior (AP) position of the C-arm, the three-dimensional ring appears as an ellipse for this fluoroscopic projection (see monitor in left picture). To obtain an optimal view of the anatomy, the surgeon moves the C-arm in such way that the ring becomes a line (see picture in the middle). This means the C-arm projection is exactly perpendicular to the aorta, which is considered as an optimal view of the anatomy of interest. The right picture indicates that this optimal C-arm angulation differs significantly from the AP position in this case.



EVAR-3D Guidance for precise positioning

After the C-arm has been positioned perpendicular to the target anatomy, the fluoroscopic markers of the graft can be aligned with the guidance ring. If required, a small amount of contrast agent can be injected to reconfirm the correct overlay of the guidance outline. In this case the final angiography shown in the lower right picture illustrates both the vascularization of the renal arteries and the correct alignment of the guidance outline with the aorta.

A total of 76 ml contrast was required in this case. Fluoroscopy was only used 14.5 minutes with a radiation exposure of 35,746 Gy^m²



Configuration of the Hybrid Operating Room

Cardiovascular and Thoracic Surgery Department,
OLV Hospital Aalst

- Artis zeego with Automap functionality
- Artis OR table with narrow tabletop
- syngo MMWP with syngo DynaCT and EVAR-3D Guidance engine
- 2k acquisition with 30x40 detector
- One monitor stand equipped with six 19" screens on a Siemens Display Ceiling Suspension (DCS)
- Four Dräger Movita ceiling supply units
- Two OR lamps by Maquet



Benefits

- Optimized C-arm angulation through guidance ring perpendicular to arteries of interest
- Precise 3D overlay because intraoperative 3D syngo DynaCT captures deformation caused by stiff catheters
- Guidewire and catheter navigation into ostia of arteries based on automatic 3D outline and interactive 3D markers



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this procedure.

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