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Robot-assisted imaging for spinal fusion

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Illustrated workflows in hybrid operating rooms, No. 2

Cliniques Universitaires Saint-Luc Brussels

Department of Neurosurgery

The Cliniques Universitaires Saint-Luc in Brussels offers approximately 1,000 beds and a wide range of treatments. Thanks to its highly specialized teams and continuous investment in state-of-the-art medical equipment, Saint-Luc is able to treat even the most complex conditions. Saint-Luc has a history of world's first treatments: world first in the field of angiomas, i.e. identification of the major cause of venous malformation, and first ever transplantation of ovarian tissue between genetically different sisters.

Prof. Dr. Christian Raftopoulos has been head of the Department of Neurosurgery at the Cliniques Universitaires Saint-Luc since 1996. In 1998 he performed the world's first implantation of an electrode around an optic nerve on a blind patient. He has become an international authority on vascular neurosurgery.

Dr. Raftopoulos shares an Artis zeego with the cardiovascular department and treats spinal fusion cases once every other week in this Hybrid Operating Room.



Clinical Case

An 88-year-old female patient presented with lower back pain. Her previous surgery was due to a traumatic fracture of L5 which required cementoplasty.

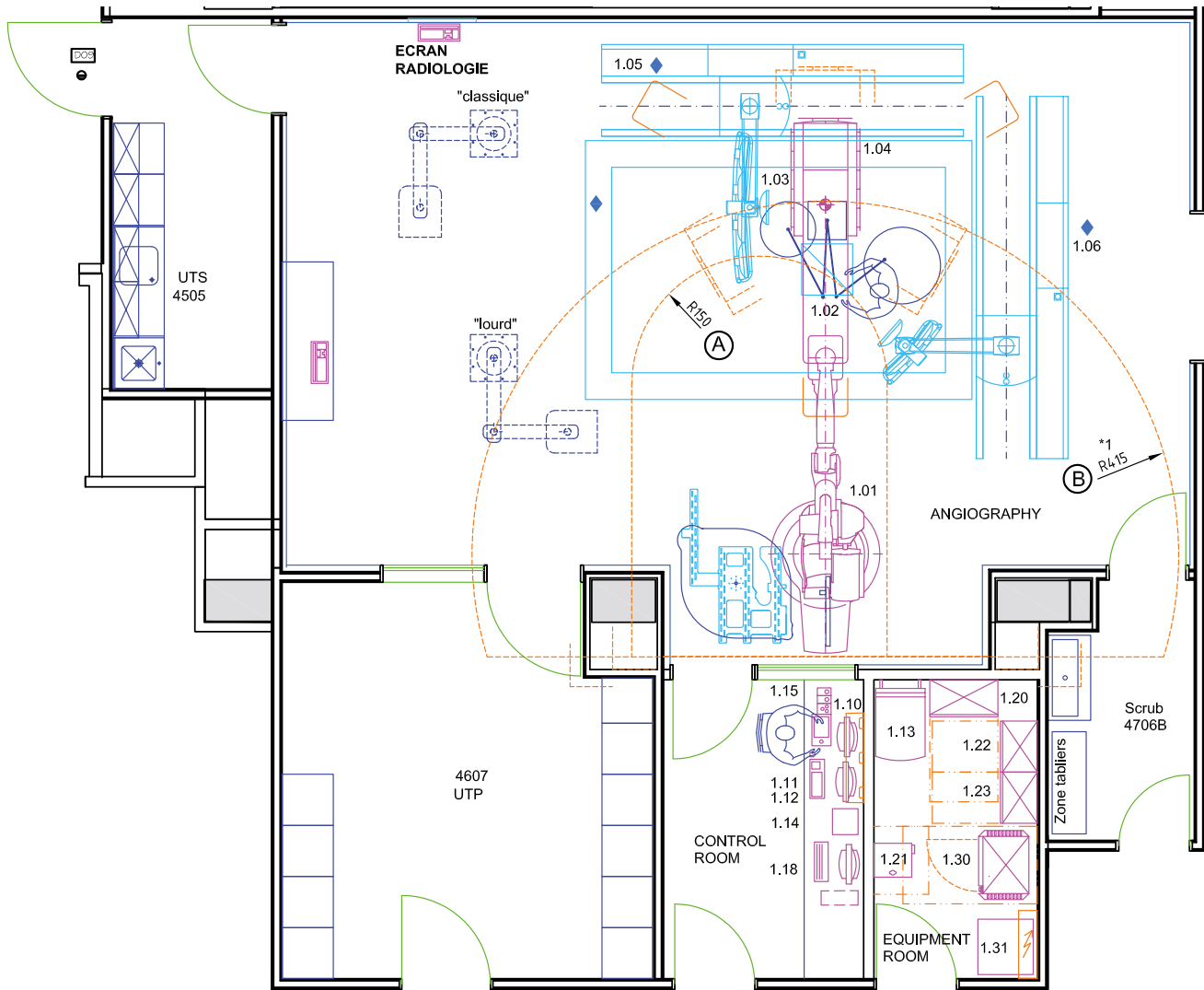
The patient was diagnosed with spinal instability in spinal levels L4 – L5 – S1. A spondylosis of L4, L5 and S1 is planned for fixation of the spine under fluoroscopic and 3D image guidance.

Room layout and position of staff

The size of the Hybrid Operating Room is about 70 m² (753 ft²) plus a control room of around 8 m² (86 ft²). The room itself accommodates two anesthesia booms, two monitor booms on Display Carriage System rails mounted next to the laminar airflow field, the C-arm, and the operating table. The laminar airflow field is installed based on site-specific requirements by the vascular department.

During the spinal procedure the patient is laid prone on the table with feet pointing to the Artis zeego. Anesthesia is placed close to the head at the left side of the patient.



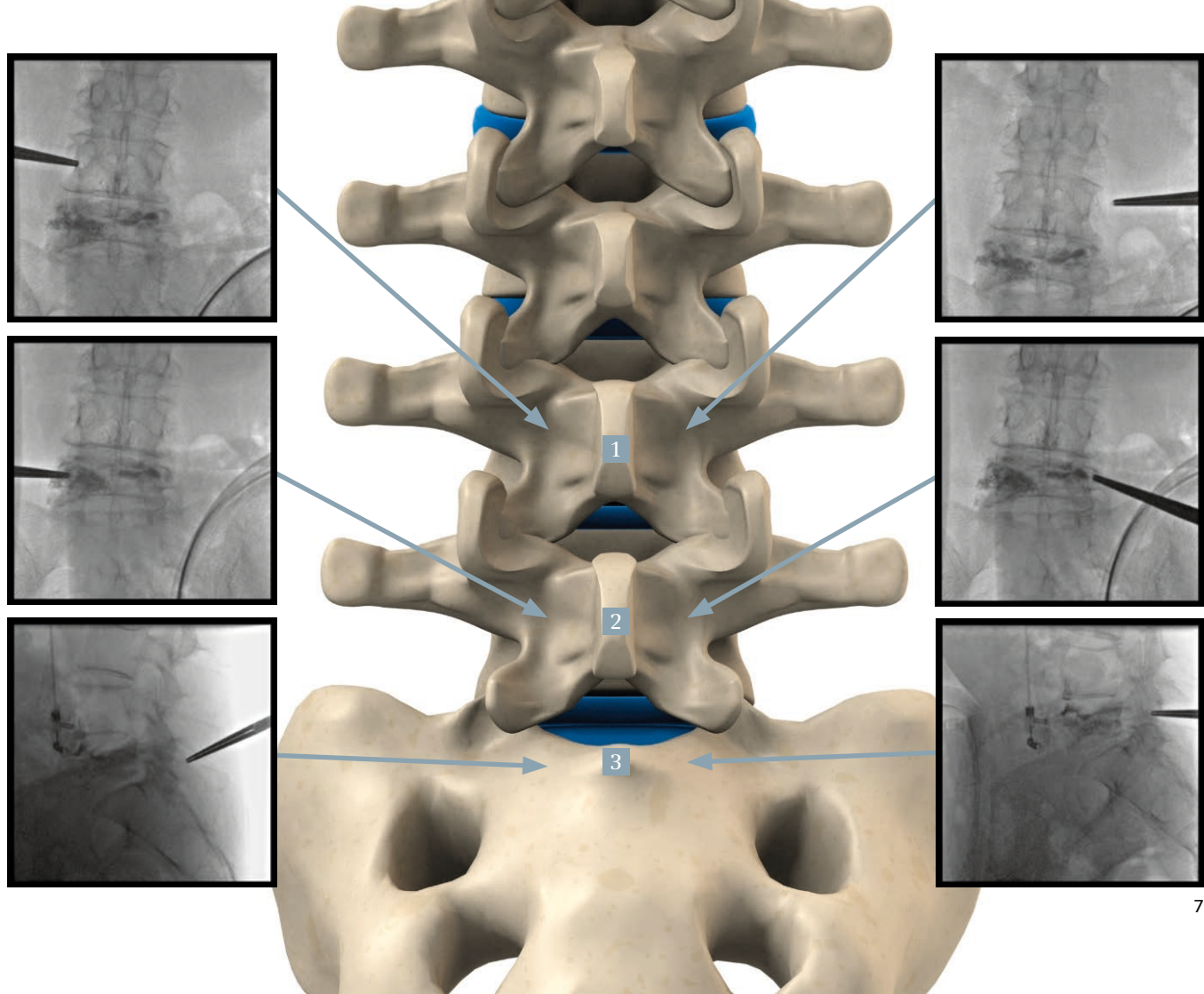


Preparation of the patient and storing preferred fluoroscopic positions

Prior to the procedure, the assisting physician drives the robot C-arms into fluoroscopic angulations that are considered to be optimal views for implanting the screws. In this case two screws in each vertebra are implanted (i.e., six fluoroscopic views are chosen).

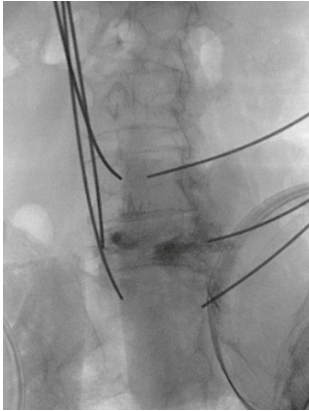
These six positions are stored as reference images and with these images the exact position and angulation of the robot arm. An additional lateral view is stored as well. During the procedures these reference positions can be recalled and the C-arm can be driven to exactly the same position without the need to apply X-ray or manual adjustment.





Placement of k-wires

For each planned screw, a k-wire is placed under fluoroscopic guidance. The surgeon selects one of the six reference positions to move the C-arm automatically into the optimal angulation for the corresponding vertebra. Since the exact angulation has been memorized by the robot system, no further X-ray dose is required to position the C-arm.



Fluoroscopy showing six k-wires.





Programmable flexibility with robot-based imaging



During the procedure the C-arm needs to be moved in and out of the surgical field to perform various steps at each vertebra. The flexibility of the robot arm enables any required C-arm positions and angulations and can be moved far away from the table to provide free access to the patient.

Preferred fluoroscopy views are stored as references in the system at the beginning of the procedure by the assistant. These positions are recalled by the surgeon during the procedure and the robot arm drives the C-arm to exactly these stored positions without further user

interaction. No readjustment or search for the correct angulations is required.

Such programmable flexibility using reference positions, called "automapping," reduces radiation exposure for the patient and staff, and speeds up the surgical workflow considerably.

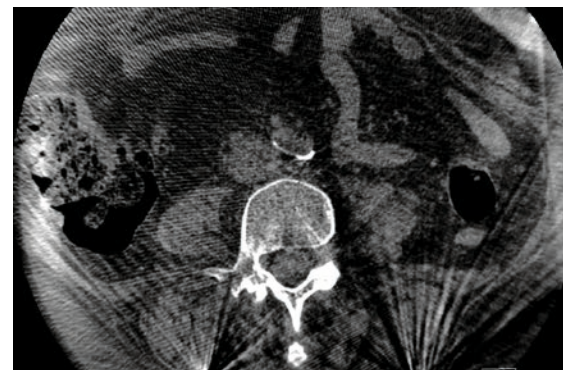
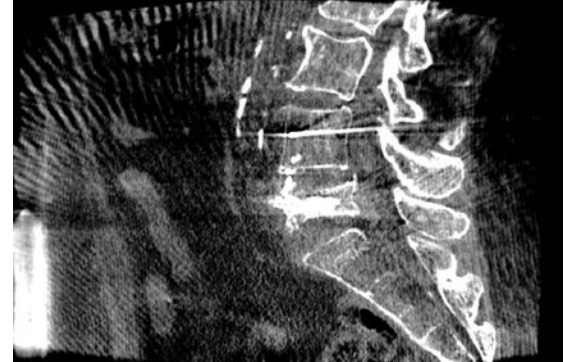


3D *syngo* DynaCT to confirm position of k-wires

After the k-wires are inserted, an interoperative 3D *syngo* DynaCT image is acquired to confirm their position. The Artis zeego system offers a range of 3D acquisition protocols providing the choice of either high image quality or low dose. In this case a low dose *syngo* DynaCT was chosen. During this protocol the C-arm rotates around the patient in 5 seconds and minimizes the radiation dose for both the patient and the OR staff.

In the illustrated case, the cement in L5 poses a problem and might lead to instability of the screws. Thus, the corresponding k-wire is re-positioned to aim the trajectory for the screw more inward and to ensure better stability of the implant.



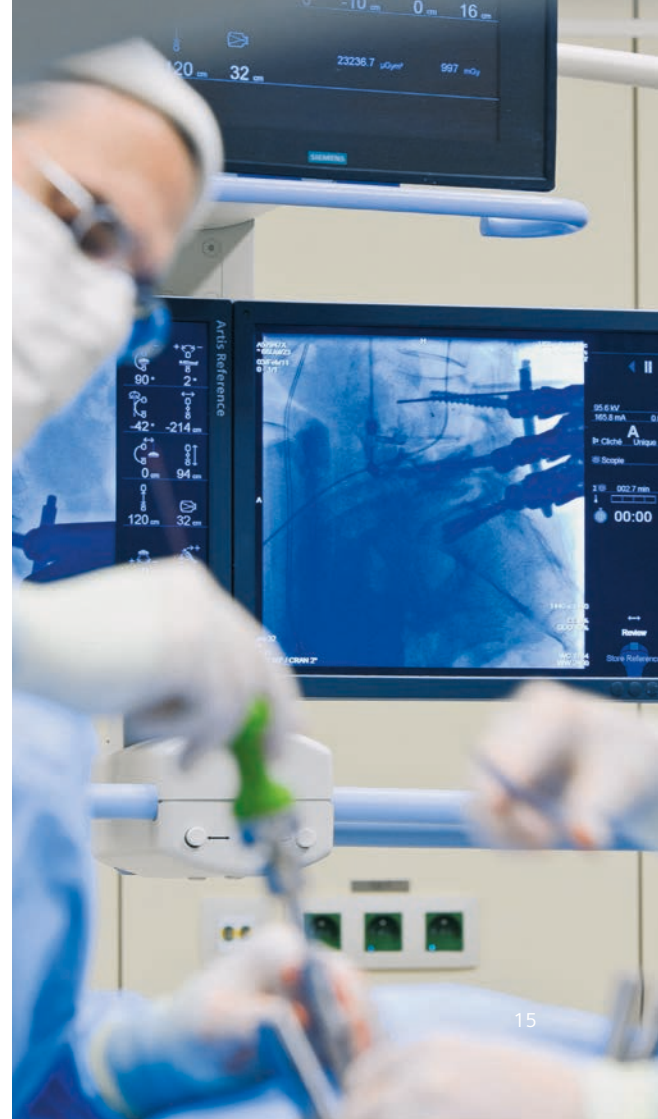


Placement and re-placement of screws

The screws are finally implanted. During the procedure, the surgeon can use the stored reference images to drive the robot to the exact positions of those images. Since the robot guarantees the identical angulation of the C-arm, the live fluoroscopy can be matched with the reference scan and directly compared. Thus, the surgeon can compare the current anatomical situation with the original anatomy at the beginning of the procedure.

For example, the picture to the immediate right shows the movable, ceiling-mounted monitors in the background. The left-hand monitor displays a reference image which was acquired at the beginning of the intervention and the right-hand monitor shows the live fluoroscopy. Note that the fluoroscopic perspectives are exactly the same for both images on the monitors.





Final confirmation of screw positions using intraoperative *syngo* 3D DynaCT

At the end of the procedure, the positions of the screws are confirmed by a completion 3D *syngo* DynaCT run. With a CT-like 3D image such as this, misplacements can be detected right in the OR. Sometimes the 3D analysis shows an imperfectly located screw. The relocation of this screw after k-wire placement is based on the initially stored reference image. Postoperative CT is no longer required to check for correct positioning of the screws.

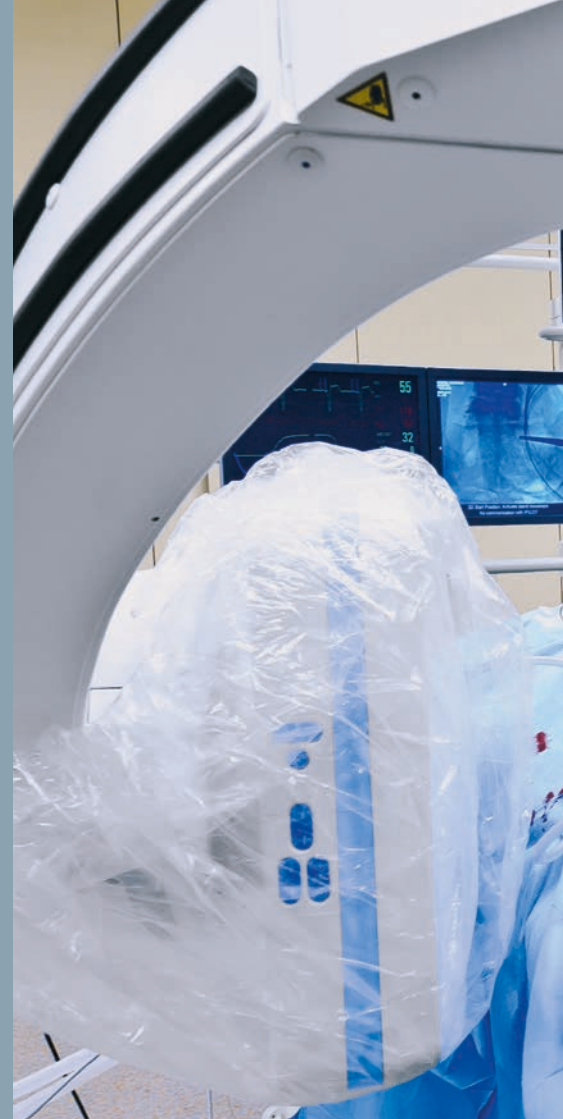




Configuration of the Hybrid Operating Room

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- Artis zeego with Automap functionality
- Artis OR table including wide tabletop
- Wireless foot switch
- syngo MMWP with syngo DynaCT, syngo 3D Basic and syngo Angio Package
- 2k acquisition with 30x40 cm detector, 3D/3D Card acquisition including DYNAVSION
- Two monitor amples, one equipped with four 19" screens and one equipped with two 19" screens
- Two anesthesia booms
- Laminar airflow field





The benefits at a glance

- Exceptional image quality and a large field of view based on high-powered X-ray tube and 30x40 cm flat panel detector not available with traditional mobile C-arms
- Peace of mind right in the OR that the screws are placed correctly using CT-like 3D imaging syngo DynaCT
- Improved workflow because the robot drives the C-arm to predefined positions
- Dose saving measures like Automap reduce radiation for the patient as well as staff
- No ceiling-mounted components in the laminar airflow, so reduced risk of infection and collision with OR lamps
- Unrestricted access to the patient



Scan this code with your smartphone to watch a video of this procedure.

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