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Electromagnetic navigation bronchoscopy
with intra-operative 3D imaging

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Illustrated workflows in hybrid operating rooms, No. 14

Prince of Wales Hospital, Hong Kong

The Prince of Wales Hospital (PWH), located in the Sha Tin district between the main island of Hong Kong and Shenzhen, is one of the most advanced public hospitals in Hong Kong and serves as a teaching hospital of the Chinese University of Hong Kong.

The 1,500 beds facility employs about 5,000 medical doctors, nurses, and other clinical staff providing 24/7 emergency services to patients from all parts of Hong Kong.



Calvin Ng and his team

Dr. Ng is associate professor in cardiothoracic surgery at the Prince of Wales Hospital Hong Kong. He graduated from Imperial College in London and completed a fellowship at the Queen Elizabeth Hospital in Birmingham. He received several awards for his outstanding contributions to thoracic surgery.

Dr. Ng is a pioneer in single-port image-guided video-assisted thoracoscopic surgery (iVATS) in the Asia-Pacific region. For the development of the iVATS procedure, he has chosen a multi-disciplinary approach combining surgery and interventional radiology. Therefore he works closely with the interventional radiologist Prof. Simon C.H. Yu.

Main areas of research and interests are:

- Innovative technologies in VATS
- Single-port iVATS
- Chest wall surgery and reconstruction
- Immune dysfunction following thoracic surgery
- Intraoperative imaging



The hybrid operating room

The hybrid operation room at the Prince of Wales Hospital is set up for cardiac, vascular, and thoracic procedures. The operating room (OR) is equipped with the robotic imaging system Artis zeego. In contrast to conventional workflows intraoperative imaging allows to evaluate and treat the patient in one session without transportation between radiology and the OR.

The OR infrastructure is designed to support a quick conversion from minimally invasive to open surgery. During open procedures the laminar airflow field ensures a high hygienic standard. The OR team can treat complex cases in the same setting and the multi-disciplinary team works seamlessly together in the same space.

The approx. 10 m x 7 m (33 ft x 23 ft) theatre also features a free-floating Artis OR table, in a 15° turned position relative to Artis zeego providing space for anesthesia. A Large Display, a syngo X workplace, a Dräger anesthetic workplace, Olympus and Karl Storz endoscopic systems as well as the Medtronic superDimension™* navigation system complement the room.

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Electromagnetic Navigation Bronchoscopy with *syngo* DynaCT

A 54-year-old male presented with a non-specific pulmonary nodule. A biopsy was scheduled for evaluation regarding malignancy of the lesion.

As the lesion was located in an endobronchially accessible branch, Dr. Ng and his team decided to perform electromagnetic navigation bronchoscopy (ENB) with *syngo* DynaCT.

Planning was based on a preprocedural CT using the Medtronic superDimension™ navigation system which reconstructed a 3D map of the patient's tracheobronchial tree based on the CT images. Dr. Ng then used this 3D map to plan an endobronchial pathway from the lesion to the trachea.

For the procedure, the patient was positioned in supine position, received general anesthesia and was intubated with a single-lumen endotracheal tube. Anesthesia is positioned at the foot end of the table, providing sufficient space for Dr. Ng to work with the bronchoscope at the patient's head end.





Navigation phase

Using the Medtronic superDimension™ navigation system, and Edge™* navigation catheter, Dr. Ng registered the patient's anatomy to the reconstructed 3D map. The Edge™ navigation catheter is located via a low frequency electromagnetic field. The electromagnetic field is generated by a location board positioned under the patient's thorax.

Using the planned pathway, Dr. Ng guided the bronchoscope to a wedged position. The navigation catheter was then advanced as close as possible to the lesion without applying radiation. When the navigation catheter was aligned to the lesion, the locatable guide (a component of the navigation catheter) was removed and a biopsy tool was inserted.

Intraoperative 3D imaging visualizes the current position of the tools and the lesion. It allows correction of the tool position if needed, which leads to more precision.

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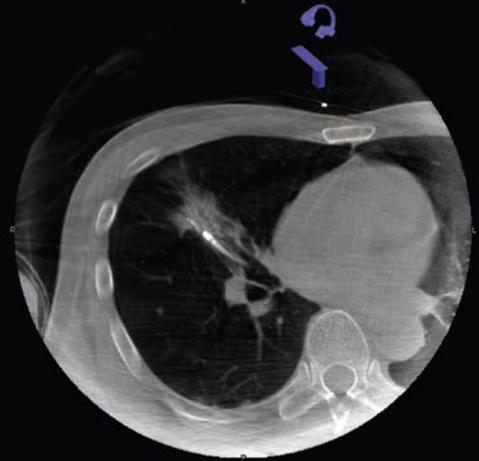
Preparation of the biopsy

Once the navigational catheter is close to the lesion, the superDimension™ navigation system is switched off and Artis zeego is moved from the park to the working position. Due to its robotic stand the system can access the patient in almost any position, even if the table is lifted, tilted, cradled or segmented.

For the procedure the Large Display was positioned at the patient's left side. While ventilation is stopped a six seconds syngo DynaCT 360 rotational angiography was performed to visualize the thorax. Image quality and soft tissue resolution are sufficient to visualize even small lung nodules of low contrast like Ground-Glas Opacities (GGO).

After validating the position of the biopsy tool fine adjustments were made using the fluoroscopic mode.





Dedicated software applications for ENB

The *syngo* Fusion Package supports image guidance during ENB. On the basis of an intraprocedural *syngo* DynaCT scan, the pathway from the lesion to the trachea can be drawn manually and overlaid upon the fluoro image for additional guidance. The overlay is dynamically registered to the C-arm. If the C-arm changes its projection, the overlay follows automatically. The Automap function helps to switch between stored viewing angles.

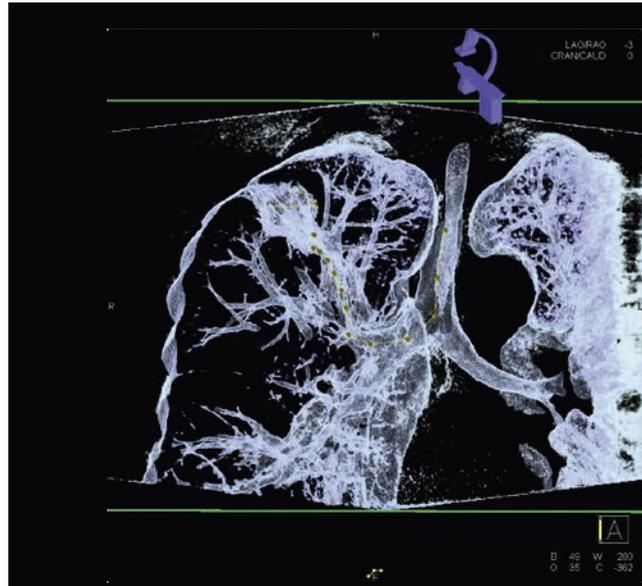
In order to reduce radiation further a preprocedural CT can be fused with fluoro by taking two fluoro shots from different angles. The 2D/3D fusion provides additional orientation for catheter navigation.

After taking the sample the suspicious tissue was sent to pathology for detailed analysis. The patient could leave the hospital the next day without complications.

Further reading

- Arias et al., *S Resp Crit Care Med*, 2014(35)
- Hohenforst-Schmidt, *J Cancer*, 2014(5)
- Ng et al., *Eur J Cardiothorac Surg*, 2016 (49)





Courtesy of Dr. Hohenforst-Schmidt, Klinikum Fürth, Germany

Configuration of the hybrid operating room

Prince of Wales Hospital, Hong Kong

- Artis zeego robotic imaging system
- Free-floating Artis OR table
- Large Display mounted on rails
- syngo X Workplace
- Steris OR lamps
- Dräger anesthetic workplace
- Dräger Motiva supply unit
- Olympus and Karl Storz endoscopic systems
- Medtronic superDimension™ navigation system
- 2.5 m x 2.5 m (8.2 ft x 8.2 ft) laminar airflow field





The Benefits

- Improved yield rate for endobronchial biopsies
- Higher precision through position check with *syngo* DynaCT
- Less radiation through combination of ENB with *syngo* DynaCT
- More patient safety because procedure is performed in OR environment
- One-stop workflow from biopsy to minimally invasive resection possible



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