Image-guided thoracic surgery in the hybrid OR

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Illustrated workflows in hybrid operating rooms, No. 12

Prince of Wales Hospital, Hong Kong

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

PWH is named after Prince Charles, Prince of Wales, who officially opened the hospital in 1984. The hospital provides approximately 1,500 beds and a 24/7 emergency service. About 5,000 medical doctors, nurses, and clinical staff take care of patients from different territories of the peninsula.

Calvin Ng and his team

Dr. Ng is an Associate Professor in cardiothoracic surgery at Prince of Wales Hospital, the Chinese University of Hong Kong. He graduated from Imperial College, London, and underwent a fellowship at the Queen Elizabeth Hospital in Birmingham. Dr. Ng 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. The development of iVATS has been multi-disciplinary, in particular he has worked closely with interventional radiologist, Dr. Chu Cheuk Man.

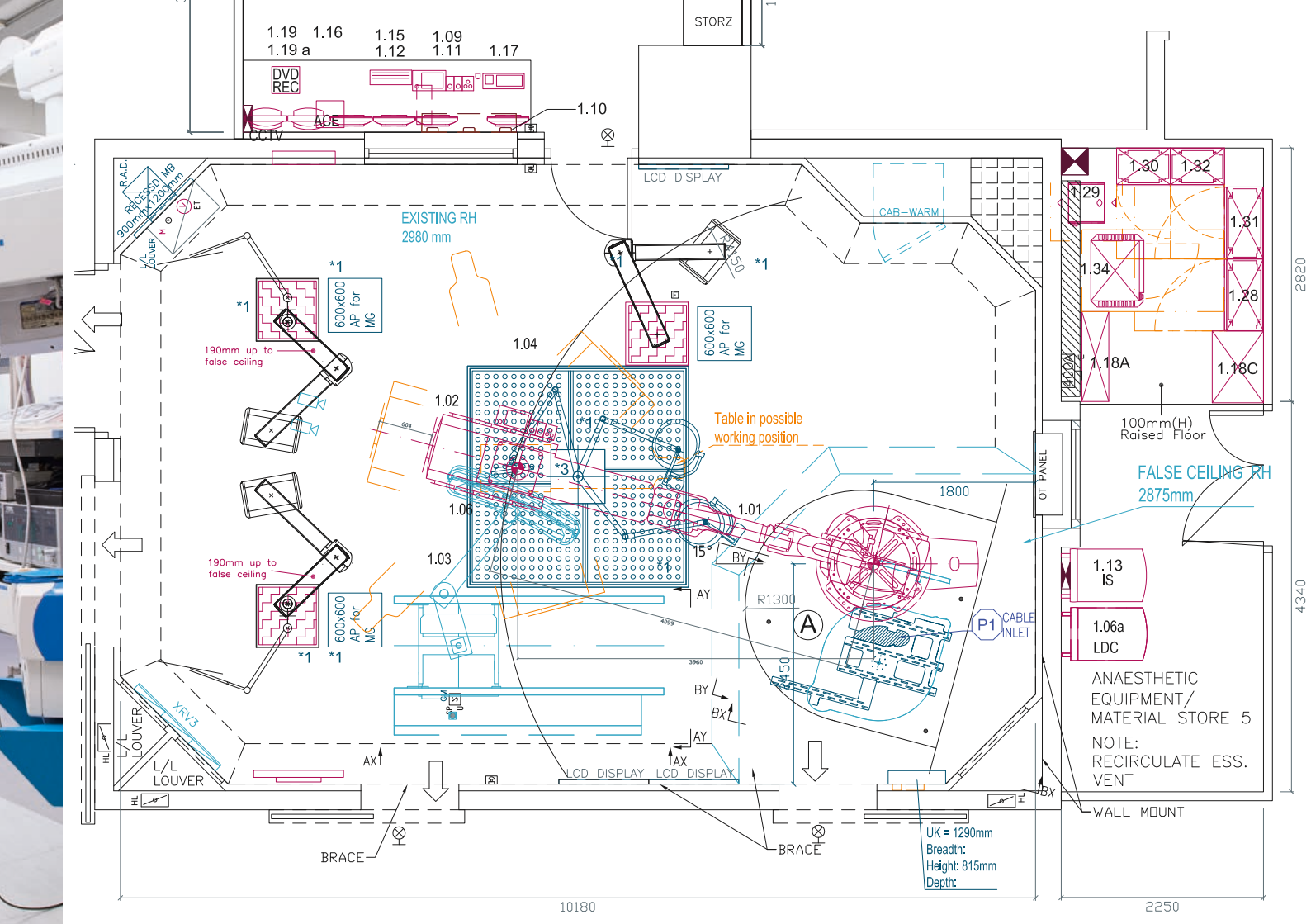
His main research areas and interests are: innovative technologies in VATS, single port iVATS, chest wall surgery and reconstruction, immune dysfunction following thoracic surgery and intra-operative imaging.

The hybrid operating room

The hybrid operating room in the Prince of Wales hospital is a cardiothoracic operating room (OR) equipped with advanced, fixed 3D imaging for complex minimally invasive procedures. Artis zeego is a robot-supported imaging system that allows evaluation and treatment of patients in one room in a single session.

The OR team works together to treat complex cases that require different disciplines. The hybrid OR has the infrastructure for quick and safe conversions from minimally invasive to open procedures.

The room size is about 10 m x 7 m. It accommodates a free-floating Artis OR table, which is placed in a 15° position relative to Artis zeego to gain space for anesthesia. Furthermore the room contains a Large Display, a *syngo* X Workplace, Steris lamps, a Dräger anesthetic workplace, Dräger Motiva supply unit, Olympus and Storz endoscopic systems, an electromagnetic navigation system, and a 2.5 m x 2.5 m laminar airflow field.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STORZ
DVD REC
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AOE
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LCD DISPLAY
CAB–WARM
R.A.D.
RECESSED MB 900mmH x 1200mm
ET
L/L LOUVER
EXISTING RH 2980 mm
*1
600x600 AP for MG
190mm up to false ceiling
1.04
1.02
1.06
1.03
1.01
Table in possible working position
*3
1800
OT PANEL
15°
BY
AY
R1300
A
P1
CABLE INLET
BX
AX
XRV3
L/L LOUVER
HL
LCD DISPLAY
LCD DISPLAY
BRACE
BRACE
UK = 1290mm
Breadth:
Height: 815mm
Depth:
WALL MOUNT
10180
1.30
1.32
1.29
1.31
1.34
1.28
1.18A
1.18C
100mm(H) Raised Floor
FALSE CEILING RH 2875mm
1.13 IS
1.06a LDC
ANAESTHETIC EQUIPMENT/ MATERIAL STORE 5
NOTE: RECIRCULATE ESS. VENT
2820
4340
2250

Image-guided localization single port lobectomy

The earlier lung cancer is detected the higher the survival rate is: According to US National Cancer Institute the 5-year survival rate of localized lung cancer is approximately 55 % compared to a regional stage where the rate decreases to approximately 27 %. Therefore screening campaigns have been launched to detect suspicious lesions as early as possible.

Because of comorbidities, shorter recovery time, and better cosmetic outcome, minimally invasive procedures are preferred by doctors and patients.

If the size of the pulmonary nodule is smaller than 1 cm and if it is located deep within the lung, intra-operative localization and tissue-sparing resection during and minimally invasive thoracic surgery is challenging.

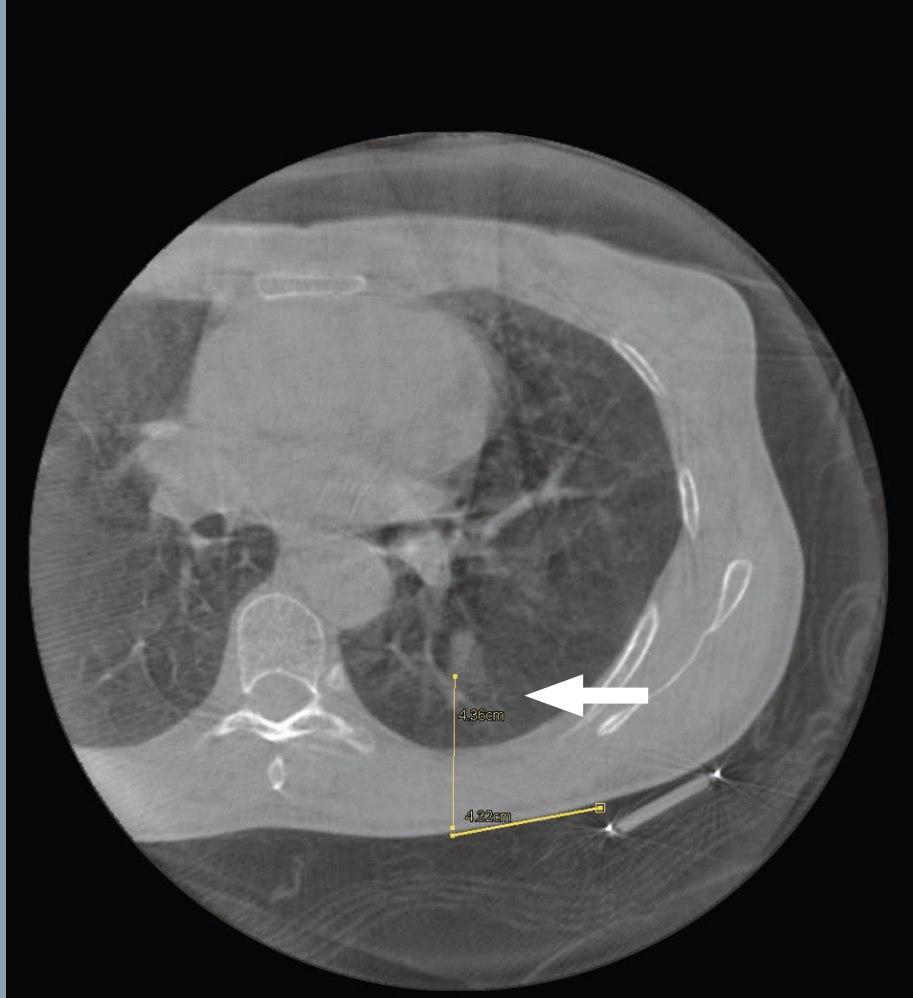
When operating with long instruments through small ports the surgeon lacks his tactile sense of touch. This deficit can be compensated by markers, which requires imaging and guidance.

Case history

A 56-year-old non-smoking woman presented with a 1-cm ground glass opacity (GGO) in the left lower lobe. The lesion was found incidentally during a CT scan. A further PET-CT revealed that the lesion was mildly hypermetabolic, with no signs of lymph node or systemic involvement.

The patient was scheduled for a hookwire localization and a uniportal wedge resection in the hybrid operating room.

The image demonstrates the high spatial resolution of Artis zeego for visualizing even GGOs accurately during intervention.



Patient positioning and procedure planning

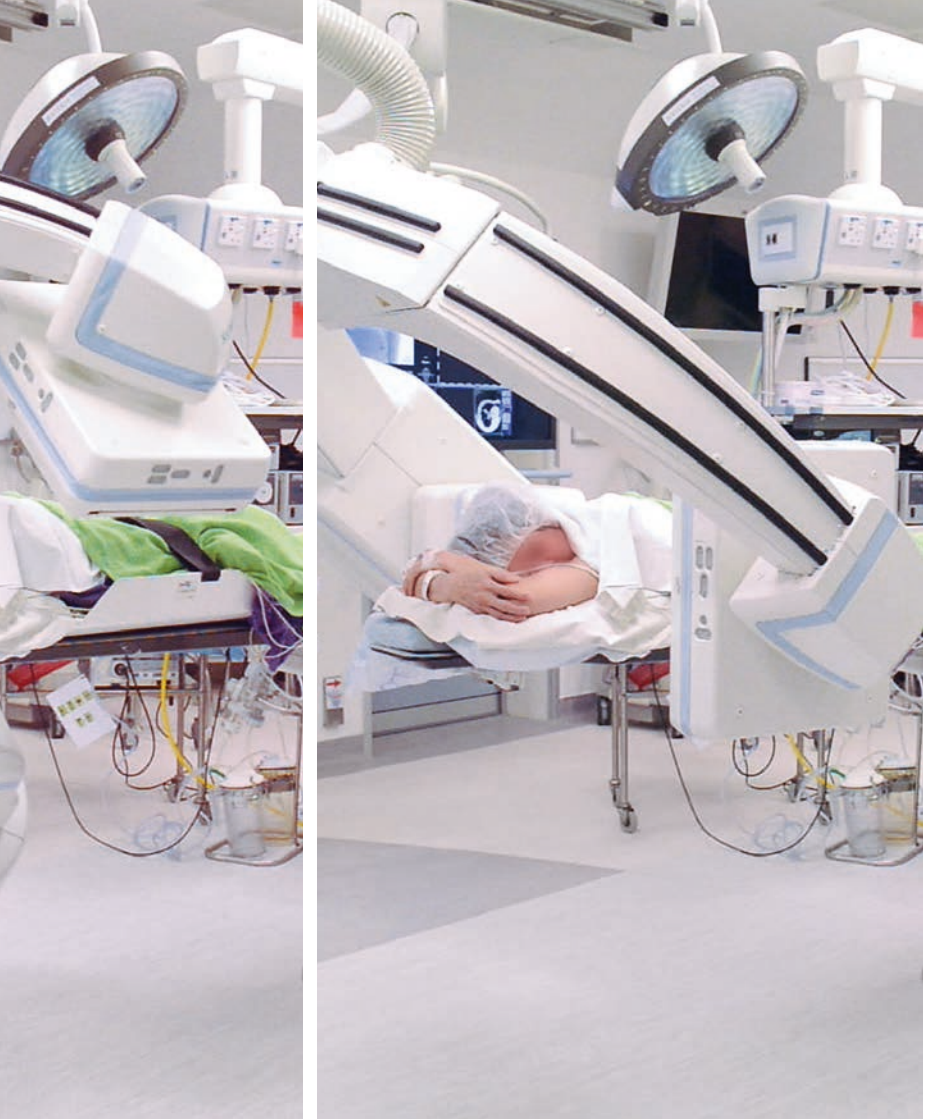
To overcome the difficulties in locating small and deep pulmonary nodules during surgery, CT-guided marking techniques have been developed (e.g., with hookwires). Traditionally, the hookwire is placed in the conventional CT suite first, followed by surgical resection in a classical operating theatre.

However, there is potential to improve. First, the logistics to minimize the time between the hookwire insertion and the surgery is complex. Second, there is a risk of a pneumothorax during the transfer. Third, the hookwire can be dislocated during the transfer. Therefore, a one-stop procedure is desirable.

Due to the posterior location of the nodule, the patient was positioned in prone position on the OR table. A *syngo* DynaCT was performed to locate the precise position of the lesion in three dimensions. Based on this image, the interventional radiologist planned a trajectory to the target.

Intra-operative 3D imaging

Advanced intra-operative 3D imaging is a main feature of a hybrid OR. From a distant park position, Artis zeego can be moved quickly to the surgical field and back. During open surgery the C-arm can be packed in fitted sterile bags. The floor-mounted stand does not interfere with the laminar air flow. This qualifies the system for hygiene level 1A, which is crucial for multi-disciplinary and high utilization of the theatre. Because of its high flexibility and full integration with surgical tables, the room can be used by different disciplines.



The target lesion was centered in the isocenter of the C-arm with two fluoro shots from anterior and lateral. These images are used to automatically determine the optimal tube parameters for the 3D run. Before the acquisition Artis zeego performs a slow test rotation to ensure collision-free rotation.

In a six-second 220-degree rotation, a three-dimensional image of the thorax was created. In this case the standard volume was sufficient. In more complex cases, Large Volume *syngo* DynaCT can visualize the whole thorax including skin through an off-center double rotation. If motion artefacts are relevant, *syngo* DynaCT 360 can be used to acquire a large volume in six seconds.

Image-guided video assisted thoracoscopic surgery (iVATS)

On the *syngo* X Workplace the interventional radiologist determined the optimal direction and depth of the needle puncture in three different view planes (left image). The needle is advanced to the target lesion and control scans were used to verify the position of the needle tip in relation to the nodule. The right image shows the anatomy after the deployment of the hookwire.

syngo Needle Guidance is a dedicated software program for image-guided video assisted thoracoscopic surgery (iVATS). It allows planning several needle trajectories in three dimensions. With the push of a button, Artis zeego switches between a parallel view and an orthogonal view of the needle for observing the progress in relation to the target. Optionally Artis zeego is equipped with a laser cross that helps the interventional radiologist to introduce the needle correctly with less radiation exposure.


syngo Workplace
Filming
3D
InSpace
Brightness
100
Opacity
80
Measure
X-Ray

Wedge resection through a single port

Once the needle was placed properly the hookwire was introduced and fixed. For the video-assisted thoracic surgery the patient was repositioned in lateral decubitus position and stabilized with cushions, with her arms placed and fixed anteriorly with sufficient exposure for access by the anesthetist.

Dr. Ng created a single port incision on the left anterior chest wall of the patient, and placed a soft-tissue retractor over the wound. With the lung deflated, the hookwire still marks the position of the nodule.

During the resection the patient was ventilated via the other lung. With endoscopic hookwire guidance the wedge containing the lesion was removed through one port. The resection was immediately sent to pathology for further analysis.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LED
HD
FWH O.T.

Single port lobectomy

Because the frozen section of the sample showed adenocarcinoma, Dr. Ng and his team proceeded with a lobectomy of the left lower lobe through the same single port. The lobectomy specimen was retrieved in a protective plastic bag to prevent wound contamination by the tumor. Systematic lymph node dissection was performed, followed by routine closure of the small incision.

The postoperative course of the patient was uneventful. The chest tube was removed two days after the procedure, and she was discharged on the same day without complications. The detailed pathological analysis found T1N0 adenocarcinoma of lung.

Further Reading

Ng et al., CHEST, 2015, 174(3): e76-8
Gill et al., J Surg Onco, 2015(112)


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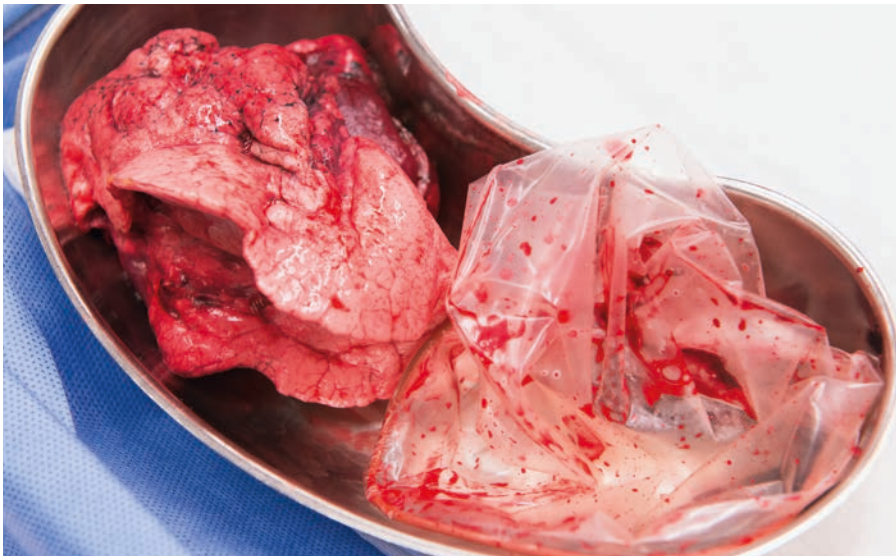

Configuration of the hybrid operating room

Prince of Wales Hospital, Hong Kong

- Artis zeego multi-axis 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 Storz endoscopic systems
- Electromagnetic navigation system
- 2.5 m x 2.5 m laminar airflow field

The Benefits

- Intra-operative visualization of sub-superficially located small pulmonary nodules
- Detection of sub-centimeter nodules that are hardly visible on CT
- Precise marking and tumor resection saves more healthy tissue
- Less invasive procedure leads to faster recovery of the patient
- Less risk through needle placement in safe OR environment
- Quick and straightforward procedure through one-stop workflows

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