New breed of operating theatres allows less invasive surgery

Hybrid theatres with built-in high-tech imaging equipment let surgeons access patients’ body through smaller cuts, boosting recovery rates

Developments in digital technology, which make it less necessary for surgeons, yet speedier and more precise, are transforming the way in which we operate and the environments in which it is being practised. Not only are these advances creating a new kind of specialist — who can operate at the minute level of tiny blood vessels and handle the muscularity of open surgery — they are also changing the way operating theatres are being designed and built.

Increasingly, hospitals are turning to hybrid operating theatres, where surgery can be done with the imaging equipment that is normally used for diagnosis. Such operating theatres are being increasingly adopted to improve both patient outcomes and patient safety.

Hybrid theatres — in which patients are operated on in a setting that also contains imaging equipment — are transforming the way surgery is being done in hospitals, said Dr Nelson Chua, a senior consultant in cardiothoracic surgery at Singapore General Hospital (SGH).

“Operate on a spot where we can see inside the patient,” he added. “The operating theatre is an extension of the anaesthetic room, and the surgeon can access the patient through a vertical tunnel into a hybrid theatre, which is like a single room with imaging equipment.”

Dr Chua has previously worked in a hybrid operating theatre located in the National Neuroscience Institute in Singapore. Since 2002, he has worked in a hybrid theatre at the National Neuroscience Institute, which was added to the hospital’s second building in 2007.

Dr Chua described three types of hybrid operating theatres: the angiography theatre, the da Vinci robotics theatre, and the digital theatre. Each type has its own advantages.

Angiography theatre

The angiography theatre is typically used for interventional procedures, such as angioplasty and stenting, for patients with blocked arteries. This theatre is used for patients with severe limb ischaemia, who have had up to 100 blocked vessels in lower limbs using angioplasty and stenting. The former involves a tiny balloon that is inserted into an artery and inflates the balloon to clear the clot. In the latter, the balloon displays a slight to keep the artery open.

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iCT
Opened in November 2007, the Khoo Teck Puat National Neuroscience Institute Integrated Neurosurgery Centre comprises three operating theatres fitted with iCT (intra-operative magnetic resonance imaging) facilities. This gives surgeons real-time scans of a patient before, during and right after surgery in the operating theatre, allowing them to monitor progress and perform more complicated operations faster. This potentially improves treatment outcomes. The integrated MRI scanner also allows surgeons to update diagnostic images needed for neurosurgery. The system manages the complex hurdles of integrating a magnet into the operating environment. The main challenges in neurosurgery include accounting for the movement of brain tissue after the surgical removal of a lesion, which is called “brain shift”, and visualising the extent to which the tumour has been removed. The only way to compensate for brain shift and to determine if the planned tissue volume has been removed is to use radiographic images during surgery. As MRI has become the gold standard for identifying lesions in the brain, intra-operative MRI is the logical continuation to help surgeons verify that the tumour has been removed completely before they finalise an operation.

The iMRI operating theatre is used mainly for neurosurgical and other cranial procedures. The common conditions treated there include: epilepsy, glioma (a type of tumour that starts in the brain or spine), cysts and arteriovenous malformations (abnormal connections between the arteries and veins in the brain that usually form before birth). The centre has operated on 500 patients in the iMRI operating theatre.

ICT
This operating theatre at Singapore General Hospital is an integrated system combining surgical planning and navigation, image data management, advanced visualisation and intra-operative (during surgery) imaging with a high-end computed tomography (CT) scanner. A CT scan generates a more detailed X-ray image. This hybrid operating theatre is especially useful for complex procedures for the brain and spine. This combination allows physicians to use slices of the X-ray in two-dimensional (2-D) and three-dimensional (3-D) imaging during surgical procedures. It works by using special computer software and hardware that allow for images of the patient to be taken in real time in 2-D and 3-D. After the CT generates the images, they are transferred from the scanner to the navigation system, which are shown on three flat-screen monitors. These images let the surgeon know exactly where the lesion is. They also guide the surgeon in finding the best direction to reach the lesion. In this way, the system acts like a global positioning system (GPS), but for surgery rather than driving. It has an adjustable operating table and an extra large CT scanner (cylinder) with a cylindrical tunnel through which patients can pass in various positions. The combination of such imaging capabilities with surgical navigation enables surgeons to perform surgery with great precision.

The combination of such imaging technologies allows the surgeon to position surgical instruments, screws and implants with greater precision for better outcomes. They also allow the surgeon to position surgical instruments, screws and implants with greater precision for better outcomes. The equipment in the theatre is networked and linked to external information sources. Real-time information from various types of equipment used in the operation is projected on a wall of monitors so all members of the surgical team can see it.

3D NAVIGATIONAL
This operating theatre combines surgical navigation with a three-dimensional (3-D) imaging device (right) for X-ray imaging during surgery.

It enables surgeons to navigate immediately using 3-D fluoroscopic images (X-ray images on a screen) which they acquire during surgery. The 3-D images and surgical equipment navigation technology, which shows current data on the anatomy, give surgeons better orientation during surgery and allow them to position surgical instruments, screws and implants with greater precision for better outcomes. This system is used mainly for brain, spinal and orthopaedic procedures, including total joint replacement for the hip and knee and osteotomy (an operation whereby a bone is cut to shorten, lengthen or change its alignment).

SIX TYPES OF HYBRID THEATRES

iMRI

ICT

3D NAVIGATIONAL

ENDO ALPHA

PHOTOS: SINGAPORE GENERAL HOSPITAL

A surgeon uses a computer- assisted spinal surgery navigation probe.

PHOTOS: SINGAPORE GENERAL HOSPITAL

Doctors can see it.