The adoption of 3D image-guided brachytherapy for cervical carcinoma is gaining momentum in Southeast Asia and heading north.

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3D image-guided brachytherapy (3D IGBT) in patients with cervical carcinoma is associated with very good clinical outcomes. This has been recognized for many years throughout the world, and is being applied actively in Europe and the United States.

During 3D IGBT, MRI images are used to contour the tumor and surrounding organs-at-risk (OAR), enabling highly accurate planning of sufficient radiation doses to better treat the tumor. At the same time, doses to OARs, such as the bladder and rectum, are reduced (figures 2-4). Despite these benefits to the patient, the adoption of 3D IGBT for cervical carcinoma is slow in Southeast Asia, but is gaining momentum.

*Figure 2: MRI axial view - contouring of the tumor and organs-at-risk (OARs)*
Challenges and opportunities for the adoption of 3D IGBT in Southeast Asia

Initially, one of the reasons for the slow acceptance of 3D IGBT has been the lack of clear guidelines for the imaging protocol, contouring, applicator reconstruction and planning with three-dimensional volumes. In 2005, such guidelines were published for the first time by the GEC-ESTRO group in Europe\textsuperscript{1}, and a second detailed guideline on dose constraints for the tumor and OARs soon followed.\textsuperscript{2} The third and fourth GEC-ESTRO guidelines were published to guide the applicator reconstruction and imaging protocol in the years 2010 and 2012, respectively.\textsuperscript{3,4}

Even more important, the clinical outcomes of treating cervical cancer patients with 3D IGBT were published in Europe in 2007 by Pötter et al.\textsuperscript{5} Subsequently, many studies have been published in international journals demonstrating the benefits of 3D IGBT in cervical carcinoma.\textsuperscript{6-9} The supporting data of 3D IGBT has therefore increased around the world.

In Southeast Asia, the implementation of 3D IGBT has relied on these supportive clinical data and guidelines. Nevertheless, there still are other obstacles hindering its adoption. These include lack of knowledge, having the necessary equipment and infrastructure and reimbursement/public health schemes for the procedure.

Knowledge is one of the easier obstacles to overcome. International, regional and national training courses by GEC-ESTRO, ASTRO and the IAEA have supported radiation oncologists and physicists from Southeast Asia in gaining the necessary knowledge to put the technique of 3D IGBT into practice. In addition, Elekta has played an important role in overcoming the knowledge barrier by supporting educational workshops in 3D IGBT. Leading physicians from Southeast Asia have attended workshops at AKH Vienna, Austria, as well as
workshops held in India (TATA Memorial Hospital in Mumbai and AIMS hospital in Kochi), Singapore (National University Hospital) and Thailand (Chulalongkorn University Hospital in Bangkok and Chiang Mai University Hospital). However, the participants who have been trained on the theory of 3D IGBT may have issues with their infrastructures when they plan to implement 3D IGBT at their centers. The next step of on-site training or practical consultancy may be important as follow up to improve the progress of 3D IGBT implementation in this region.

The lack of equipment and infrastructure is a more difficult obstacle to address. Access to CT or MRI for brachytherapy is still one of the factors inhibiting the implementation of 3D IGBT today in Asia. Although the installation of MRI simulators has increased, it is difficult for some institutes in Southeast Asia to acquire MRI for their brachytherapy workflow. A compromise is to use CT instead of MRI. A CT-based contouring guideline linked to the GEC-GESTRO recommendations supports CT-based IGBT for cervical carcinoma. Moreover, the local availability of specialized applicators compatible with the imaging devices is another obstacle. The conventional (metal) applicator causes many CT artifacts that affects target/OAR determination, and standard applicators cannot be used in the MRI magnetic field. The use of CT/MR applicators solves this problem, but sufficient funds to buy new applicators are required. This may delay 3D IGBT in some centers.

The impediment of a lack of a reimbursement infrastructure varies in its severity between countries. Reimbursement depends on each government’s policy, whereas today, in many countries in Southeast Asia, government health schemes for brachytherapy are often limited to non-existent, with no additional reimbursement for using 3D IGBT. As a consequence, in many cases today in Southeast Asia, the use of 3D IGBT is limited to patients with private insurance.

Some or all of these difficulties have meant that the shift from 2D to 3D brachytherapy for cervical carcinoma in Southeast Asia has been quite slow. With increased awareness and more available data supporting 3D IGBT for cervical carcinoma, the reimbursement for this procedure may change at the policy level.

Regarding clinical studies of 3D IGBT in Asia, centers - for example TATA Memorial Hospital in India - have actively participated in the multi-center international EMBRACE study, which is investigating clinical outcomes with MRI-based 3D IGBT. After the training in 3D IGBT for cervical carcinoma at the Medical University of Vienna, the Chiang Mai IGBT team started its own 3D IGBT research project in 2008. The experience of the radiation oncologists and the physicists at Chiang Mai is that 3D IGBT improves the quality of treatment in cervical carcinoma. Their experience showed that better dosing was achieved for treating the tumor in combination with a lower dose to the OARs, such as bladder and rectum.

3D IGBT also has the advantage of allowing the performance of more sophisticated applications, such as the use of interstitial needles with the Interstitial CT/MR Ring applicator or the Utrecht CT/MR applicator. Even better coverage of the tumor can be achieved using these techniques, while
still sparing OARs (i.e., bladder, rectum). The clinical results at Chiang Mai University Hospital have revealed good clinical control and a low toxicity profile. With all these positive results, it is the belief of many radiation oncologists that 3D IGBT for cervical carcinoma should become standard of care for cervical carcinoma in Southeast Asia in the near future.

**Pamela Youde Nethersole Eastern Hospital (PYNEH) - Hong Kong**

**Implementation of 3D IGBT in Hong Kong**

Pamela Youde Nethersole Eastern Hospital (PYNEH) was among the first hospitals in Hong Kong to treat a patient with cervical carcinoma following the new GEC-ESTRO Guidelines, using MRI- and CT-based planning and advanced imaging and target definition techniques.

PYNEH physicists and radiation oncologists overcame some of the aforementioned obstacles by using the available educational and support opportunities at renowned centers in the UK and USA, as well as the AKH Vienna in Austria. Collaboration within the department with nursing support, as well as other disciplines including gynecologists, radiologists, and anesthesiologists is essential for the development of this new technique.

Patients were treated according to the AKH Vienna protocol. As it has been common practice to use tandem & ovoid applicators in the department, Utrecht CT/MR applicators were used for the insertion in the first few patients. Subsequently, the Vienna ring applicator was introduced into the practice and used in suitable patients. Following the insertion of the applicator in the theater, a MR scan was obtained and the radiation oncologist began contouring the tumor and OARs. Brachytherapy planning was carried out by a physicist and the radiation oncologist. Applicator reconstruction and dose optimization were performed and the plan was counter-checked by another physicist and radiation oncologist before the patient began treatment (see figure 6).

In line with the Vienna protocol, brachytherapy was delivered in two consecutive days, with the last day being the elective treatment day.

Figure 5: IGBT team members - Pamela Youde Nethersole Eastern Hospital (PYNEH) - Hong Kong. The team include members from different departments, Clinical Oncology, Medical Physics, Diagnostic Radiology, Obstetrics and Gynecology, and Anesthesiology.

Figure 6: MRI based brachytherapy plan
weeks and each week the patient underwent two fractions of treatment with one applicator insertion. This meant that the applicator was in place in the patient overnight. For the second fraction on day 2, a CT scan was obtained and fused with the MR images of day 1. Target volumes and OARs were contoured on the CT images for treatment planning on day 2.

![Figure 7a: physicists perform a planning accuracy check](image)

![Figure 7b: a 3D CT/MR applicator is used for the 3D IGBT treatment](image)

It has been a very steep learning curve to move from conventional 2D planning with radiographs to complete 3D planning and optimization. So much additional anatomical and dosimetric information, as well as a new level of flexibility in plan optimization is available compared to 2D planning. Linking our previous experience with the new technique was not trivial. It is especially challenging to bridge the conventional dose point requirements and 3D dose constraints. Even our prescription method has evolved accordingly following our increasing experience in 3D planning.

The clinical and physics team were very proud to be one of the first hospitals in Hong Kong to start this advanced brachytherapy technique. Many hospitals throughout Asia are currently or will soon be following suit with 3D IGBT treatments in patients with cervical carcinoma, to optimize clinical outcomes for their patients.
References


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The company was founded in 1974 by Professor Lars Leksell, a physician. Today, with its headquarters in Stockholm, Sweden, Elekta employs around 4,000 people in more than 30 offices across 24 countries. The company is listed on NASDAQ OMX Stockholm.