Implementation of image guided brachytherapy

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Brachytherapy is derived from the ancient Greek words for short distance (brachios) and treatment (therapeia). It refers to the therapeutic use of encapsulated radionuclides placed within or close to a tumour. For nearly a century it has played a pivotal role in the curative treatment of many cancers but, with the advent of enhanced afterloading devices, artificial radionuclides, enhanced computer planning software and three-dimensional imaging, it has evolved dramatically in the last two decades.

Until relatively recently, most European centres localised the brachytherapy target using plain (two-dimensional) imaging with the assistance, in some situations (eg cervical cancer), of radio-opaque dye in the bladder and/or rectum. Such a technique does not permit contouring of the three-dimensional extensions of the target (CTV) or the organs at risk (OAR). Furthermore, when using such a technique, the dose report is related to the geometry of the implant rather than the target volume. Three-dimensional image guided brachytherapy (IGBT) allows for accurate verification of applicator position, more precise definition of normal tissue dosimetry, the ability to conform dose to the CTV/OAR (figures 1a and 1b) and the potential for dose escalation.

It is in gynaecological cancer that brachytherapy is most frequently employed and in 2005 the European Brachytherapy Society (GEC-ESTRO) published recommendations for the use of IGBT in cervical cancer.¹ These have been endorsed by the American Brachytherapy Society and are now the international standard. In 2009 the UK Royal College of Radiologists published their guidelines for implementing such a practice.²

The transition to IGBT planning and delivery involves a steep learning curve but mirrors the evolution that has occurred with respect to external beam therapy, and the rewards are starting to be realised. Preliminary data suggest that IGBT in cervix cancer is probably safer and more efficacious than previous techniques for delivering brachytherapy.³ It would seem logical to suppose that the same will be true for other tumour sites. A report on the substantial progress that the UK has made in implementation was published in 2011.⁴ In that, the number of centres offering such technology increased from 26% in 2008 to 71% in 2011 and there has been a five-fold increase in the use of MRI-based treatment. Similar progress has occurred in many other departments across Europe, North America, Australasia and Asia. These centres are therefore an invaluable resource for those that are yet to implement the service.

It must, however, be remembered that the move to image guidance represents a departure from what has been standard practice in many units for decades and it is therefore imperative that this is executed in a methodical and cautious manner.

The following is by no means an exhaustive list of requirements but highlights what are probably the essentials for developing an institutional IGBT programme.

• A 3D imaging tool that permits visualisation of the applicators in situ. MRI allows for better soft tissue definition than CT but, to date, there is no evidence, at least in cervical cancer, to suggest that toxicity or local control rates are any different. This is, of course, reassuring considering the limited access that many radiotherapy departments have presently to MRI.

• In using CT it is preferable (and for MRI essential) to use plastic applicators/catheters. The anatomical distortion created by metallic devices on CT creates difficulty when contouring the target and OARs.

• IGBT involves concepts that may be unfamiliar to clinicians, radiographers and physicists. There is, therefore, a certain amount of staff training required. While clinical oncologists have considerable experience in radiological anatomy (particularly CT), it is significantly advantageous to have the assistance of a radiologist when contouring the CTV and OARs. This is particularly important in centres where physicists and/or radiographers take an active role in volume delineation. By virtue of the steep dose gradients and high doses utilised in brachytherapy it is imperative to ensure that volumes are as accurate as possible. Additionally, training is required in dose evaluation, optimisation and modification as well as applicator reconstruction and quality assurance.

• Teaching courses and practical workshops are (like other established centres) an excellent resource and are predominantly provided by organisations such as ESTRO and ASTRO.¹ In the UK, following the RCR recommendations, the Department of Health has produced an e-learning programme to support the implementation of IGBT for cervix cancer.²

• Institutional written guidelines and work instructions are essential as, of course, is regular audit and practice review.

• A certain amount of investment is inevitably required. Much of this will most likely already be in place if a centre has an existing brachytherapy service. Additional funding may be required, for example for equipment (applicators and consumables), a treatment planning system, staff training and radiology/anaesthetic support.

Above all, it is probably a motivated and focused multidisciplinary team that most significantly helps establish and run a comprehensive and effective IGBT programme.

References
2. Implementing image-guided brachytherapy for cervix cancer in the UK. The Royal College of Radiologists; 2008.
7. www.e-lfh.org.uk/radiotherap-e
Figure 1A and B
Axial (A) and sagittal (B) CT image (ring and tandem delivery of brachytherapy in cervix cancer) showing the 100% isodose (red) and its relationship to the rectum (brown), sigmoid (green) and the bladder (yellow).