IGRT and its practice parameters

Introduction

Image-guided radiation therapy (IGRT) employs imaging to maximise accuracy and precision throughout the treatment process. This process involves target- and normal-tissue delineation, radiation delivery and adaptation of therapy to anatomical and biological changes over time. I focus here on image guidance at the time of radiation delivery to ensure its adherence to the planned treatment, referred to as in-room IGRT.

Thus IGRT is particularly applicable to highly conformal treatment modalities such as 3D conformal radiation therapy (3D CRT), intensity-modulated radiation therapy (IMRT) or proton/hadron therapy. In the case of stereotactic body radiation therapy (SBRT) or stereotactic radiosurgery/stereotactic radiation therapy (SRS/SRT), IGRT is considered a necessary and integral component of the entire procedure. Nevertheless, accurate delivery of radiation therapy is important even for simple treatments.

Practice parameters in India

A) Qualifications and responsibilities of personnel

If the radiotherapist's certification does not include IGRT, then specific training in IGRT should be obtained for performance of any stereotactic procedures. The responsibilities of the radiation oncologist, medical physicist and radiation therapist (RTT) should be clearly defined.

Radiation oncologists

Radiation oncologists manage the overall disease-specific treatment regimen. They recommend and approve appropriate patient-positioning methods, and they approve the use of each chosen procedure to account for intra-treatment motion/variation (e.g. breathing movement) for targets that are significantly influenced by such motion. They contour the outline of the targets and organs at risk. They convey case-specific prescriptions of the radiation dose to the target volume and set limits on the potential doses to adjacent normal tissue. After they have obtained informed consent for the treatment, they oversee the actual treatment process. They participate in the quality assurance (QA) processes, such as the approval of IGRT assessments.

Medical physicists

Acceptance testing and commissioning of the IGRT system are performed by medical physicists. Through the performance of these procedures they ensure its mechanical, software, and geometric precision and accuracy, as well as image-quality verification and documentation. They implement and manage a QA programme for the IGRT system to monitor and ensure each of the following:

a) the geometric relationship between the image-guidance and treatment-delivery systems; and
b) the correct functioning of the registration software that compares planning-image to IGRT datasets.

Radiation therapy technologists

1. They learn the correct use of the patient immobilisation/repositioning system and the fabrication and understanding of the correct use of devices for IGRT.

2. They perform the initial (planning) simulation of the patient's treatment and generate the medical imaging data that are appropriate for the treatment planning system.
3. They implement the IGRT treatment plan.
4. They acquire verification images for review by the radiation oncologist.
5. They evaluate the stability and ongoing reproducibility of the immobilisation/repositioning system and report inconsistencies immediately to the radiation oncologist and the medical physicist.

B) Clinical IGRT implementation

Introduction of IGRT in clinical applications involves a comprehensive evaluation of device operation, acceptance/commissioning, the establishment of routine QA procedures, identification of appropriate disease sites, and creation of disease-site- and/or technique-specific policies/procedures. Sufficient staff training is essential to conduct a safe and efficient IGRT programme for targeting and reduction of margins.

It is the responsibility of all staff to keep their knowledge up-to-date regarding the technology and operational details of newly introduced IGRT devices, e.g., MRI guidance, fiducial markers with electromagnetic localisation and dose tracking, and improved imaging techniques that involve the use of CT, ultrasound and/or camera-based systems.

The commissioning/acceptance of these IGRT systems should follow technical recommendations from professional organisations. IGRT has been implemented routinely for the treatment of various disease sites, such as brain, head and neck, lung/thorax, breast, liver, prostate, gynaecological tumours, spine, and for techniques such as IMRT and SBRT/SRS. The frequency of IGRT usage should be carefully balanced among the disease treatment, imaging dose and resource requirements.

C) Documentation

Successful IGRT implementation involves specification of the type of imaging modality used, its frequency, and the anatomical or fiducial targets employed. As noted above, various verification methodologies of IGRT implementation are in current use, and one or more appropriate methodologies should be incorporated into the patient's record, as part of the documentation of treatment parameters.

D) Quality control and improvement

Examinations should be systematically reviewed and evaluated. Monitoring should include evaluation of the accuracy of interpretation as well as the appropriateness of the examination. Complications and adverse events or activities should be monitored, analysed and reported as required and periodically reviewed in order to identify opportunities to improve patient care.

E) Safety and patient education

Each facility should have policies and procedures in place that provide for the safety of patients and personnel. These should include attention to the physical environment; the correct use, storage, and disposal of medications and hazardous materials and their attendant equipment; and methods for addressing medical and other emergencies.
Each facility should have policies and procedures in place to educate and inform patients about procedures and/or interventions to be performed and facility processes for the same. These should include appropriate instructions for patient preparation and aftercare, if any.

Summary

The use of IGRT systems is essential in the treatment of any site where set-up deviations and organ motion are anticipated. Additional gains are the monitoring of treatment response, weight changes, and organ filling on a day-to-day basis. With improved precision of planning systems, use of SRS or SRT, and high-dose hypo-fractionated regimens, the chances of small deviations that lead to significant errors in treatment delivery are increased, and the use of IGRT is far more critical in these situations. Integration of linear accelerators with MR-based soft-tissue imaging and PET-based biological imaging may help to improve targeting accuracy even further in the future. However, it is mandatory to ensure that staff are well trained and that QA is undertaken at all steps for optimum use of such technology and its integration into routine use.

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