RP in Radiotherapy : new radiotherapeutic techniques

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Abstract. This paper introduces shortly three main relatively new radiotherapeutic techniques used in the radiotherapy departments; Image Guided Radiation Therapy an imaging technique for positioning and repositioning the patient, Intensity Modulated Radiation Therapy an optimized conformal 3D technique giving better healthy tissues sparing and respiratory gating used in moving targets. These techniques participate in the optimisation process of patient irradiation.

Keywords : Image Guided Radiation Therapy, Intensity Modulated Radiation Therapy, respiratory gating

1. Introduction

The main objective of external radiation therapy is to deliver the prescribed dose to the target (s) while delivering the lowest possible dose to organs at risk in the vicinity of the target (ex: prostate versus rectum and bladder, head and neck cancer versus bone marrow, parotides), in order to obtain better control tumour while minimizing toxicity. It is indeed a process of optimization.
The emphasis for this keynote lecture will instead be on three growing techniques that have a potential high impact on patient treatment: Image Guided Radiation Therapy (IGRT), Intensity Modulated Radiation Therapy (IMRT), and Respiratory Gated Radiotherapy.

2. New radiotherapeutic techniques

2.1 Image Guided Radiation Therapy

Image Guided Radiation Therapy (IGRT) uses an embedded imaging device with the linac, that allows for real-time positioning and repositioning of the patient. There are several available technological solutions, however Xray imaging projection or slice-type Cone-Beam Computed Tomography (CBCT) are currently the most represented. Images of the patient, acquired in position of treatment, are compared to the reference images from the dosimetric Computed Tomography (CT) scanner using an image fusion software application. Calculated offsets are set by automatic (or manual) adjustment of the treatment couch bearing the patient, leading to an online correction. The merge-registration process is based on either patient bony structures, or metallic implants that were first introduced in the moving target of the patient (prostate, liver, lung). In addition CBCT and Mega Voltage Computed Tomography (MVCT) imaging techniques open a new perspective called adaptive radiation therapy, by giving the possibility to perform a new treatment planning after each treatment fraction. Paper size: Standard, 21 cm × 29.7 cm (A4) vertical (portrait).

2.2 Intensity Modulated Radiation Therapy

Intensity Modulated Radiation Therapy (IMRT) is an optimized technique of 3D conformal radiotherapy, allows for a better target coverage and a relative improved protection of healthy surrounding tissues. IMRT has been developed for more than a decade and uses innovations in inverse planning software solutions as well as linacs technological improvements. Particularly progress in multileaves collimators (MLC) design. MLC optimizes the fluences issued from fixed beams delivered to the patient by using the definition of objectives to target dose and dose constraints at the organs at risk given as input to the inverse-planning software application. Solutions combining arctherapy and IMRT are coming. These solutions go one step beyond in complexity. The latest development of current IMRT techniques is represented by helical radiation therapy (tomotherapy), which combines a CT scanner to a linac and a binary MLC. The linac developed by Tomotherapy (HiArt II) combines IGRT and IMRT in the same equipment. Targets coverage and organ at risk sparing have no equivalent at this time.

A major drawback of IMRT is the level of "low doses" inherent to the technique that are delivered to the patient. This potentially limits the applicability of this technique, for example in the domain of children treatment. Deep scientific research is needed to assess the effect of low doses in terms of risk of secondary cancers induced by IMRT.

2.3 Respiratory Gated Radiotherapy

In respiratory gating the linac is driven by patient respiratory cycle. The main objectives of respiratory gating are: improving the image quality of the CT scanner used for the treatment planning, immobilizing a tumor volume located in a mobile area, decreasing irradiated volumes (reduced margins: setup margin and movement margin) and thus reducing side effects (toxicity). Gating requires the use of specific equipment to reduce both the uncertainties of interfractions positioning: to ensure the positioning and repositioning of the patient, intra fraction to immobilize as much as possible the target volume. Several methods exist for example and mainly using:

- a spirometer (coaching patient with treatment in a specific phase of the respiratory cycle),
- infra red reflectors located on the skin of the patient moving according to patient respiration, allowing to deliver the treatment breathing free according to a specific phase of the respiratory cycle .

Standard abbreviations are acceptable in the text, but must not appear in the title or abstract of the paper. For local or newly coined abbreviations, the original term must be spelled out and enclosed in parentheses in its first usage within the text. For example, "Advanced CANDU Reactor (ACR)".

4. Conclusion

The main objective of new available radiation therapy techniques such as IMRT, respiratory gating, stereotactic irradiations associated to imaging techniques (IGRT) is to optimize patient irradiation by maintaining optimal target coverage, good sparing of healthy tissues, organs and reproducible patient positioning. Both material and human resources are needed in order to implement these radiation therapy techniques, and a specific organization is required to ensure and maintain rigorous quality and safety of the treatment.