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Technical note

Implementation of intensity modulated radiotherapy for prostate cancer in a private radiotherapy service in Mexico

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ABSTRACT

Intensity modulated radiation therapy (IMRT) allows physicians to deliver higher conformal doses to the tumour, while avoiding adjacent structures. As a result the probability of tumour control is higher and toxicity may be reduced. However, implementation of IMRT is highly complex and requires a rigorous quality assurance (QA) program both before and during treatment. The present article describes the process of implementing IMRT for localized prostate cancer in a radiation therapy department. In our experience, IMRT implementation requires careful planning due to the need to simultaneously implement specialized software, multifaceted QA programs, and training of the multidisciplinary team. Establishing standardized protocols and ensuring close collaboration between a multidisciplinary team is challenging but essential.

1. Introduction

The concept of intensity-modulated radiotherapy (IMRT) first appeared in 1960, and in 1966 the Sloan Kettering Memorial Cancer Center was the first to treat patients with this new technology.[4] IMRT is a significant advancement in the field of Radiation Oncology, as it allows a better conformity of the dose delivered to the tumour and lymph nodes, while avoiding irradiation of adjacent healthy structures. As a result, there is a potential decrease in the likelihood of complications associated with irradiation of these normal surrounding

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tissues. However, high-quality IMRT requires the support of medical physicists and detailed knowledge of three dimensional (3D) anatomy and patterns of disease spread.[1]

In recent years, dose escalation has been shown to improve the probability of local tumour control in prostate cancer. As a result, a growing number of radiotherapy departments have incorporated IMRT into their routine work, and many more centres are in the process of doing so.[2,3]

Our own recent experience in implementing IMRT has shown us that this is a complex, time-consuming, and expensive process. Some centres, particularly smaller ones, may find the process to be daunting. However, despite the obstacles and difficulties, it is feasible to implement IMRT if a well-planned approach is taken.

The aim of the present article is to describe the process of implementing IMRT for prostate cancer in a private radiotherapy centre. Our experience may be useful to other centres that wish to implement IMRT.

2. Hospital description

Médica Sur is a large, privately owned hospital located in Mexico City, Mexico. The hospital has 170 beds and treats approximately 1200 patients per month. The Department of Radiation Oncology is staffed by 20 physicians, 2 nurses, 4 medical physicists, 2 dosimetrists, and 8 technicians. On average, the department treats approximately 600 patients per year. Available equipment includes 2 Varian linear accelerators, one Siemens 16-slice PET-CT unit (shared schedules for virtual simulation), 4 treatment planning systems (TPS) with Eclipse v 7.3 software, and Varis Record and Verify system (R&V) database.

3. IMRT: description

IMRT is a specific radiotherapy technique delivered by a linear accelerator equipped with multileaf collimator (MLC) in which the beams are modulated to produce highly conformal dose distributions. A primary objective of IMRT is to reduce the dose to critical organs to preserve their function by restricting the entire radiotherapy dose only to the treatment volumes. However, the successful delivery of IMRT requires precise, reproducible, and reliable patient positioning, in addition to a rigorous quality assurance (QA) program overseen by medical physicists. IMRT is administered through treatment fields, each of which is individually modulated. The intensity of these variable doses can be managed by the segments in each treatment field.

4. IMRT vs. conventional 3D planning

IMRT planning is conceptually very different from conventional planning. In IMRT, the radiation oncologist must delineate treatment volumes (tumour, lymph nodes) and critical organs (rectum, bladder, spinal cord, saliva glands, eye, etc.), whereas in conventional 3D planning, large fields are used to compensate for daily variations in positioning and the physical characteristics of the radiation beam. The dose distribution in conventional 3D planning is calculated in a planning process called "forward planning" which involves calculating the angle of incidence, the weight or contribution to the total of each beam, and the necessary beam modifier. IMRT, in contrast, requires that the radiation oncologist defines specific doses to the volumes of interest: the gross tumour volume (GTV), clinical target volume (CTV), the planning target volume (PTV), and to critical organs and planning risk volume (PRV) in accordance with ICRU 50/63/82 guidelines.[5] The computerized IMRT planning software creates a series of modulation patterns in each incidence angle for the beam and the prescribed doses are obtained by an iterative algorithm. This process is known as "inverse planning".

5. Development of a protocol

A protocol was created to standardize IMRT treatment procedures for localized prostate cancer. This protocol was developed in accordance with clinical guidelines and a review of the literature to guarantee quality assurance (QA) with regards to technical aspects of treatment and correct physics. The following procedures were implemented.

5.1. *Patient preparation*

The day prior to the simulation, patients are instructed to eat a bland diet and to take 2 enemas (one at night and the other on the day of the simulation) to avoid movement of the rectal wall caused by the presence of faeces or gas in the rectum.

Thirty minutes prior to the simulation, the patient is instructed to completely empty the bladder, drink 500 ml of water, and retain the urine until the end of the procedure.

5.2. *Treatment simulation*

After 30 min have passed, the patient is positioned in the dorsal decubitus position on the computed tomography (CT) scanner, with the legs resting on a commercial immobilizing cushion (CIVCO; Kalona, IA, USA), hands crossed over the chest, and the head resting on a support. The radiotherapy technician creates reference points by placing radiopaque markers on the skin of the patient at the abdominal or pelvis: 3 markers are used for axial alignment, one for sagittal alignment, with 2 other markers (one on each knee) to coincide with the cushion markers. CT slices (3 mm) are obtained in an area that ranges from 5 cm above to 5 cm below the treatment site. The reference marker sites are then immediately tattooed and magnetic resonance images (MRI) are acquired under the same positioning conditions, except that the metallic clips are replaced by vitamin E markers. The same segment of the abdominal-pelvic region is scanned with MRI using the same CT parameters in T2-weighted sequence.[6]

These protocols assure that each treatment is performed under standardized conditions that can be repeated on a daily basis.