Radiation therapy is an important component of the armamentarium currently used in the management of prostate cancer. Several factors have recently changed the face of prostate cancer radiotherapy: the advent of advanced techniques (modern brachytherapy, different forms of conformal external radiotherapy [RT]), the use of adjuvant androgen deprivation, the confusion of different outcome end points, the difficulty of assessing treatment complications, the importance of patient satisfaction, and the impact of cost control. This chapter will cover relevant technical aspects of the modern delivery of radiation, related anatomical and dosimetric considerations, patient selection, importance of different prognosticators, the use of different end points in the evaluation of outcome, treatment results, and expected toxicity.

RELEVANT ANATOMY

Both normal and tumor anatomies have to be taken into consideration in the determination of RT target volumes. Relevant anatomic issues to radiation therapy include the relationship of the prostate and seminal vesicles to surrounding structures, and organ motion. Tumor anatomy issues include an understanding of the patterns of intraprostatic and extraprostatic disease extent.
Normal Anatomy

Unlike surgery, radiation therapy relies on indirect visualization of the target. Historically, bony landmarks with/without bladder and rectal contrast were used to localize target volumes. Currently, computed tomography/ultrasound (CT/US) images are used for that purpose. Bony landmarks are a crude way of localizing the prostate and relevant periprostatic tissues. Even with bladder and rectal contrast, the anterior and inferior (apical) extents of the prostate, as well as the location and size of seminal vesicles are impossible to determine. CT- or US-based RT has made the use of bony landmarks for the design of radiation fields largely obsolete. In addition, conformal RT with small target volumes has made prostate motion a crucial parameter to understand and address.

Prostate and Periprostatic Tissues on CT and US

Prostate volumes as determined on a CT scan are invariably larger than determined on prostatectomy specimens or on US. CT is central for external beam RT planning. US is crucial for modern brachytherapy. It has largely replaced CT-based brachytherapy planning. The presence of the periprostatic venous plexus makes the prostate appear larger on CT. In addition, the prostate gland is difficult to define at the base and apex. Target outlines are exaggerated at the base and apex, leading to larger volumes. It is possible to see a faint hypodense line on CT cuts, especially through midgland, delineating the border of the actual prostate. There is evidence that CT is more reliable in determining the apex than urethrogram(1). It is crucial not to confuse the bulbous part of the bulbospongiosum for the prostate gland, by using the crurae as landmarks delineating the most inferior extent of the apex. CT overestimates the prostate volume by 75% compared to actual volumes determined on prostatectomy specimens (2). CT overestimates the prostate volume by 20–25% compared to volumes determined on US. On transrectal ultrasound, the prostate apex and base are somewhat better defined. However, brachytherapists still feel more comfortable overestimating the prostate volume at the base and apex, partly for dosimetric considerations.

Seminal vesicles have a variety of shapes and positions. CT adequately determines the boundaries of the vesicles. However, seminal vesicles are subject to significant motion. Finally, CT is the noninvasive method of choice to evaluate lymph nodes. However, the incidence of detection of gross adenopathy is extremely low. In addition, with nodal coverage being used only occasionally, precise localization of the draining lymphatics is not critical.

Organ Motion

Organ motion is a major confounding factor in modern external beam radiotherapy. It is practically a nonissue for brachytherapy. Over the past decade, it has been increasingly recognized that the prostate and seminal vesicles change their position on a daily basis. Different technologies have been used in the evaluation of the magnitude and implications of organ motion (3–13). Prostate motion is dependent on bladder and rectal filling in the prone position, and mainly dependent on rectal filling in the supine position. The magnitude of the motion is most pronounced in the anterior/posterior dimension (mostly within 1.5 cm), significant in the superior/inferior dimensions (mostly within 1.0 cm), and least in the lateral dimension (<1 cm). Translation and rotation also occur to a lesser degree, and are mostly incorporated in motion analyses in the anterior/posterior, superior/inferior, and lateral dimensions.