Editorial

Imaging for radiation treatment planning and monitoring in prostate Cancer: Precision, personalization, individualization of therapy

Radiation therapy plays an important role in the treatment of primary prostate cancer [1]. The significant advantages of radiation therapy in comparison to radical prostatectomy (also an important treatment option for this tumor entity), are the non-invasive character of the treatment and the relatively good results concerning preservation of urinary and sexual function. However, although the curative chance is high and the rate of side effects low, there are patients presenting either local recurrence after the treatment, or side effects, or both. The higher the irradiation dose the higher the tumor control, but also the higher the risk of side effects [2,3].

Visualization of gross-tumor volume in prostate, made possible by the recent developments of magnetic resonance imaging (MRI) and positron emission tomography (PET) techniques, gives rise to new strategies in the management of the primary prostate cancer through irradiation: hypofractionated radiotherapy, stereotactic radiation therapy/radiosurgery, focal external beam radiation therapy or brachytherapy and proton therapy [4].

This virtual special issue of Physics and Imaging in Radiation Oncology presents some of the new modalities for the visualization of prostate cancer in vivo using MRI and PET, and shows how these investigations improve target volume delineation for radiation treatment planning as well as treatment guidance and how they support a better evaluation or prediction of treatment results.

The issue addresses the anatomical imaging of the prostate, as visualized on MRI as compared to computed tomography (CT) and investigates its implications for target coverage and dose to organs at risk [5,6]. This issue also presents, on the other side, functional imaging techniques to localize and characterize prostate cancer. New PET tracers for this purpose are reviewed by Zamboglou et al. [7] and a study by Tulipan et al. [8] aims to identify if dynamic PET techniques reveal similar perfusion characteristics as dynamic contrast-enhanced MRI. Olsen et al. [9] provide a tutorial overview of the most common as well as a few upcoming functional MR imaging techniques that may serve as a tool towards individualized radiotherapy. The characteristics of the prostate cancer as revealed on MRI, may also have potential as biomarkers for outcome of the treatment. Two studies investigate radiomics feature analysis of MRI, both anatomical (Fernandes et al.) [10] and diffusion-weighted MRI (Lee et al.) [11] for this purpose.

These studies are all in line with the future goals of radiation oncology to visualizing (through highly sophisticated imaging methods) both the morphology and the biological characteristics of tumor and organs of risk [12]. Understanding these characteristics will enable a differentiated dose delivery and fractionation, forming this way the basis for a personalized treatment in radiation oncology. Algorithms computing and mapping the likelihood of tumor presence, tumor-control probability (TCP), and normal-tissue-complication probability (NTCP), will also feed on these tumor/normal tissue characteristics and improve this way the treatment outcome. Finally, the delivery of such personalized treatments with sophisticated dose distributions, requires a high precision in treatment delivery. Pedersen et al. [13] applied dose response models for both tumor control and normal tissue complications to explore the benefit of proton therapy (PT) combined with focal tumor boosting, also when accounting for inter-fractional motion. Two studies in this issue address the potential improvement of treatment plans [14] and the clinical experience [15] with MRI-guided radiotherapy to realize this level of treatment individualization.

Three concepts define the modern medicine: precision, personalization and individualization. A deep understanding and an appropriate utilization of imaging in radiation oncology will help to achieve these goals. Prostate cancer presented in this issue is a model – lessons learned here could be extrapolated to other tumor entities.

Declaration of Competing Interest

The authors declare no conflicts of interest.

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