Introduction to Radiobiology and Novel Radiotherapy Technologies

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The aim of radiotherapy is to deliver a high enough dose to the tumour to sterilize it whilst delivering as low a dose as is reasonable achievable to the surrounding normal tissues and organs at risk. Achieving this delicate balance has been a major challenge for decades and has driven technological, biological and clinical developments since the first treatments were delivered.

In this current era of radiotherapy the ability for greater accuracy in imaging, volume delineation, positioning and delivery have been enhanced by increased understanding of the biological effect of delivering treatment over different time frames, at different energy levels and with different beam types.

New technologies, such as proton beams, and newer techniques such as IMRT, VMAT and Sterotactic Radiotherapy enable more focused treatment delivery but are dependent to a large extent on more accurate definition of the full tumour volume. Stereotactic radiotherapy can be delivered using either a single or a limited number of fractions which has a greater effect on the tumour than on normal surrounding tissues[1]. Imaging methodologies such as PET give greater accuracy of the position and extent of the tumour facilitating more accurate prognosis initially and a tailored individual approach to subsequent treatment.

Radiobiology underpins our understanding of the action of radiation at the cellular level. A greater understanding of the mechanism of tumour and normal tissue interaction with radiotherapy have led to the use of a range of dose and fractionation schedules tailored to the physiology of different tumour types. The Regaud carried out the pioneering work in fractionation in the 1920s cited by Soren Bensen[2]. The radiobiological effects associated with advanced technology have also been subject to recent review[3].

Linking together the new technologies, treatment methodologies and radiobiology as, for example, in the review by Francesco Tommasino and Marco Durante[4] enables a wide spectrum of approaches to treatment delivery resulting in better outcomes both from a morbidity and mortality perspective coupled with more efficient and effective use of resources.

Key to achieving these outcomes are good collaboration and communication between the imaging and treatment departments and their personnel. The importance of this level of communication between the different professionals involved in image acquisition and treatment is of high priority and leads to a greater understanding of the important factors from both perspectives, less frustration and a better quality of treatment for patients.

References

1 Carben Rubio et al. Extracranial sterotactic body radiotherapy. Review of the main SBRT features and indications in primary tumours. Reports of Practical Oncology and Radiotherapy 2013, 18, 387 – 396

2 Soren Bensen. Fractionation Effects in Clinical Practice 2015. 3 Fractionation Effects in Clinical Practice. http://clinicalgate.com/fractionation-effects-in-clinical-practice/ 2015

3 Wayne D. Newhauser. A Review of Radiotherapy-Induced Late Effects Research after Advanced Technology Treatments. Frontiers in Oncology 2016.

4 Francesco Tommasino and Marco Durante. Proton Radiobiology. Cancers 201, 7, 353-381

5 Mary Coffey and Aude Vandeering. Patient setup for PET/CT acquisition in radiotherapy planning' Radiotherapy and Oncology V.96; 3: 298-301.