Editorial

Dose Calculation Accuracy of Radiotherapy Treatment Planning Systems in Out-of-Field Regions

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Along with chemotherapy and surgery, radiotherapy remains as an important modality in tumor treatment, as it is used to treat approximately 50% of all patients with localized cancer [1-3]. However, the use of radiotherapy inevitably leads to exposing the organs/tissues that are entirely or partially excluded from the treatment volume [4]. Therefore, out-of-field regions receive dose values due to secondary radiation sources, including scattered radiation from collimators and beam modifiers, photon leakage through the treatment head of the linear accelerator (Linac), and internal patient radiation scattering [5]. In a study by Kase, *et al*. [6], it was found that the radiation scattering from patient is the main cause of dose near the edge of treatment field, while the leakage radiation has the main contribution at large distances from the edge of treatment field. Although dose value in out-of-field region is smaller than that in-field region, these doses can induce secondary malignancies with a long-latency period (particularly in radiosensitive tissue/organs) [7-8]. Furthermore, knowledge of the peripheral dose can be of very interest when considering radiation therapy for patients with pregnancy or patients with cardiac pacemaker. Therefore, accurate measurement of the peripheral dose to normal tissue outside the target volume is essential, to have an adequate clinical decision for patients with implanted electronic devices or pregnant patients as well as more accurate estimation of the radiation-induced secondary cancer risk.

Generally, it has been accepted that the dose calculation accuracy in out-of-field regions by treatment planning systems (TPSs) is poor. This can be found out by reviewing the specified protocols for quality assurance and commissioning of TPSs, which suggest an agreement criterion of up to 50% in the low dose/small dose gradient region of photon beams between the TPS calculations and experimental measurements [9-10]. There are several factors which can affect poor performance of TPSs in out-of-field regions, including the lack of TPS commissioning for out-of-field regions, the limitations of TPSs in modelling the dose contributions from contaminated electrons originated from the collimator assembly, flattening filter, and secondary scattered photons from the Linac's head [11-12].

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Received: 21 January 2018
Accepted: 28 March 2018

There are several studies which have quantified the dose calculation accuracy of different TPSs in out-of-field regions [5, 12-16]. In a study, Huang, et al. [5] reported that Pinnacle TPS underestimates the out of field dose by an average of 50% for intensity modulated radiation therapy (IMRT) treatment plans and this underestimation is worsened with increasing distance from the edge of treatment field. Howell, et al. [12] stated that Eclipse TPS underestimated out of field doses by an average of 40%. Bahreyni Toossi, *et al*. [13] revealed that TiGRT TPS generally underestimated out-of-field dose by an average of 39% and this underestimation increased for areas which are relatively close to the edge of treatment field. In another study, Bahreyni Toossi [14] investigated dose accuracy of TiGRT TPS for head and neck region and revealed it for most of the points, the difference between calculated and measured dose for out-of-field regions are less than 40%. Morever, their findings demonstrated TPS underestimated dose of the outside field which is mentioned compared to the corresponding measurements. Farhood, *et al*. [15] reported that TiGRT TPS underestimated the out-of-field dose for most points in physical wedged field and the confidence limit value for region was 55.24.

Consequently, underestimation of the dose was received by a radiosensitive organ using a TPS, so it leads to increase the probability of contracting another cancer to an underestimation of the risk of induction of second cancer. As it was stated by Kry, *et al*. [17], a 50% variation in low dose value can enough so as to cause a remarkable difference in the second cancer risk. On the other hand, a severe underestimation of out-of-field dose can lead to a poor clinical decision-making for patients with implantable electronic devices or pregnant patients. Therefore Thus, an assessment of dose at out-of-field regions should not generally rely on TPS calculations. It menas for accurate evaluation of out-of-field dose values other dose reconstruction methods should be utilized to reveal accurate evaluation of it. These methods can include calculations by Monte Carlo simulations or other analytical models, measurements in a phantom, or other calculation methods [18].

Conflict of Interest

There is not any relationship that might lead to a conflict of interest

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