Exposure levels from CT scanning for treatment planning in radiotherapy

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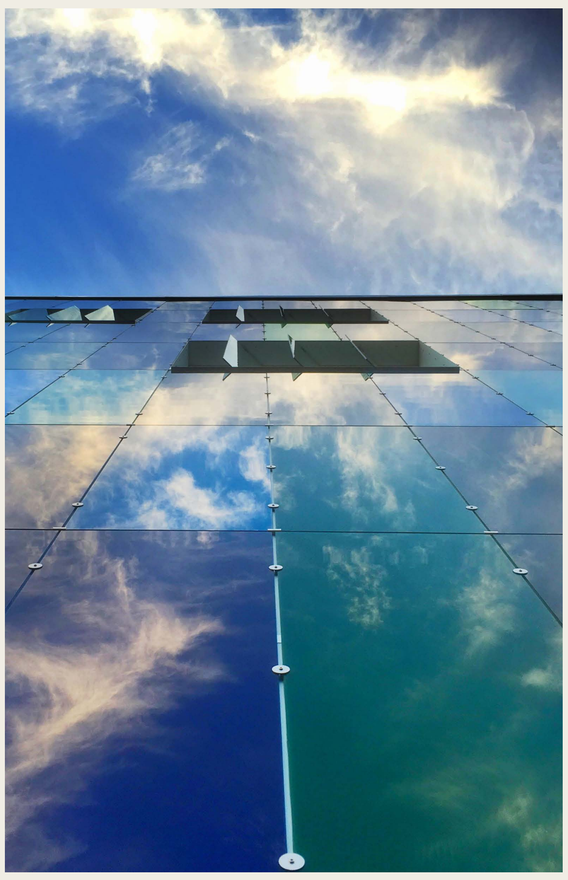

Conclusion

CT exposure levels have been evaluated for the head, head & neck, thorax, breast, abdomen and prostate regions used in radiotherapy. For $CTDI_{vol}$, these exposure levels turn out to be lower or in par with current national diagnostic radiology dose reference levels indicating well adapted scan protocols. Scan length requirements for treatment planning do however add to DLP making them higher than current DRL levels.

Introduction

Oncologic patients are commonly subject to many examinations involving ionizing radiation occasionally leading to substantial dose levels. Treatment planning is one of the steps during the radiotherapy procedure and the data from the CT scan is used in the dose calculation for the treatment plan.

CT-scanning for treatment planning in radiotherapy is however often hampered by the fact that scan parameter optimization possibilities may be limited due to treatment planning system constraints. One of the more common constraints is that only a certain kVp may be used for all scan protocols, regardless of patient habitus, as the Hounsfield unit to electron and mass density conversion is energy dependent.

Radiation doses for oncologic patients are in many cases high and the CT dose may be comparably low. However, patients are becoming increasingly long time survivors and hence the exposure levels should be monitored and kept reasonably low. This may be achieved if a set of Dose Reference Levels (DRL) – similar to Diagnostic Reference Levels – are available.

The current work reviews the exposure levels for a selected group of frequent treatment locations, i.e. head, head & neck, thorax, breast, abdomen and prostate in our institution scanned during the first eight months of 2017.

Methods

Equal scan protocols, based on filtered back projection, are set on the two scanners (twin Siemens Somatom Definition AS+) in the oncology department. Scan parameter optimization include dose current modulation and organ characteristic. No kV modulation (120 kVp was used during scanning) or iterative reconstructions were used at this time. Thorax and breast protocols are equal. Abdomen and prostate are equal protocols as well.

After each examination, scan parameters from the CT scanners are automatically transferred to our dose monitoring system (Sectra DoseTrack). The DICOM SR protocol is used for data transfer. The following parameters are included, but not limited to: $CTDI_{vol}$, DLP, weight and age.

$CTDI_{vol}$ is based on the 16 cm phantom for the head region while all other locations are based on the 32 cm phantom size. Patient groups head, breast and prostate have predefined scan lengths based on anatomy. Remaining scan groups are fully individually planned scans.

For adult patients with weights between 60 – 80 kg the median $CTDI_{vol}$ (mGy) and DLP (mGycm) values as well as standard deviations (1 SD) have been calculated for each treatment location. A minimum of 20 or more patients were required for each treatment location.

Results

The exposure levels for the selected sites are more or less equal between the two scanners and shown in the table to the right. These levels are comparable to Toroi *et al*[1].

CTDI values are in par with current national diagnostic reference levels, although these values are given as 75th percentiles, in diagnostic radiology were these are given[2]. DLP values are however outside the diagnostic DRL values were these exist. Increased scan length requirements due to treatment planning flexibility, dose calculation accuracy and DVH evaluation of complete organs add to higher DLP.

Patient groups having predefined scan length based on anatomy show smaller standard deviations than the group based on individual scans (thorax and abdomen).

Location	Scanner	$CTDI_{vol}$ (mGy)	DLP (mGycm)	Number of patients
Head	CT 1	41±4	1125±145	33
	CT 2	42±6	1168±222	75
Head & neck	CT 1	11±1	452±61	36
	CT 2	11±1	458±89	49
Thorax	CT 1	9±3	390±161	123
	CT 2	9±2	412±136	110
Breast ca	CT 1	9±2	355±61	75
	CT 2	9±1	357±60	61
Abdomen	CT 1	17±3	815±239	107
	CT 2	17±3	801±177	108
Prostate ca	CT 1	17±2	783±119	44
	CT 2	17±2	813±110	50

References

1 P Toroi, S Kaijaluoto, R Bly: Patient exposure levels in radiotherapy CT simulations in Finland. Rad. Prot. Dosim. 167, 602-607 (2014)

2 SSMFS 2018:5: The Swedish Radiation Safety Authority's regulations on medical exposures (*in Swedish*). ISSN 2000-0987. Swedish Radiation Safety Authority, Stockholm, Sweden (2018)

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