Conclusion: Peripheral dose for the Cyberknife® M6TM version is lower than previous Cyberknife® versions. Nevertheless, for a brain treatment the dose can reach 10 Gy in the thyroid and can exceed 7 Gy in gonads; it should be evaluated for every localization. Peripheral dose will depend on number of monitor units, beam aperture size and collimator system. These parameters should be optimized during treatment planning to limit peripheral dose as lower as possible.

References:

EP-1623
Correlation of organ doses and IEC and AAPM methods for cone beam computed tomography (CBCT)
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Purpose or Objective: Several dosimetric methods were proposed to overcome limitations of the standard dose index used for CT dosimetry (CTDI100) with cone beam computed tomography (CBCT). Two of these methods were proposed by IEC and AAPM. The aim of this project was to investigate the correlation between organ doses (ODs) resulting from head, thorax, and pelvic CBCT scans and the IEC and AAPM methods.

Material and Methods: The IEC method (CTDIIEC) is based on measuring CTDI100 using a reference beam and the application of a correction factor based on free-in-air CTDI measurements, while the AAPM method f(0) is based on measuring cumulative dose using a small ionization chamber at the middle of an infinitely long phantom. CTDIIEC was evaluated within CTDI head and body phantoms, whereas f(0) was assessed within 450 mm long CTDI phantoms. CTDIIEC and f(0) were measured at the centre and periphery of the phantoms using head, thorax, and pelvic scanning protocols used in the clinic. ODs were evaluated in terms of absorbed dose to organs and tissues using Monte Carlo simulations on the ICRP-110 adult male and female computational phantoms. BEAMnrc and DOSXYZnrc user codes were utilized to simulate On-Board Imagery (OBI) system mounted on a TrueBeam linac and to assess ODs using the same scanning protocols used for CTDIEC and f(0). The correlation was studied as the difference between weighted correlation was investigated for organs, which have higher weights of effective dose.

Results: For head scan, CTDIIEC,w were smaller than doses to bone marrow, brain, and salivary gland by 4-55% for male and by 16-84% for female. f(0)w was also smaller than doses to bone marrow and salivary gland by 7-26% and 49-50% for male and female, respectively, but was larger than brain dose by 15% and 5%, respectively. For thorax scan, doses to bone marrow, lung, breast, and oesophagus were underestimated by CTDIIEC,w and f(0)w by 61-100% and 35-58% for male and by 108-161% and 64-106% for female, respectively. However, CTDIIEC,w, f(0)w overestimated doses to stomach and thyroid by 10-34% and 29-45% for male and by 13-28% and 31-43% for female, respectively. For pelvic scan, CTDIIEC,w and f(0)w were smaller than doses to bone marrow and urinary bladder by 91-173% and 51-116%, respectively, but were larger than colon and gonads doses by 30-78% and 44-82%, respectively, for male. For female, however, doses to all the organs were underestimated by CTDIIEC,w, f(0)w by 76-204% and 40-141%, respectively.

Conclusion: The correlations between CTDIIEC,w and f(0)w and ODs were comparable to the majority of organs. In general, however, f(0)w gave a better estimation for ODs compared to CTDIIEC,w for the scanning protocols studied.

EP-1624
Influence of organ motion on radiation-induced secondary cancer for VMAT and IMPT of prostate cancer
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Purpose or Objective: An elevated risk of radiation-induced secondary cancer (SC) in directly irradiated tissues such as the bladder and rectum has been observed in prostate cancer patients following radiotherapy (RT). There are considerable fluctuations in SC risk due to inter-patient anatomy variations, indicating the relevance of also including the effects of internal organ motion for individual patients. Both the bladder and rectum are highly mobile structures and the aim of this study was therefore to investigate the influence of organ motion on SC risk.

Material and Methods: Simultaneously integrated boost treatment plans were generated on the planning CT (pCT) scans of eight prostate patients, using volumetric modulated arc therapy (VMAT) and intensity-modulated proton therapy (IMPT). Both VMAT and IMPT plans were prescribed to deliver 67.5 Gy to the prostate and 60 Gy to the seminal vesicles over 25 fractions, using fiducial marker based image guidance. Each patient had 8-9 repeat CT (rCT) scans throughout the course of treatment on which the bladder and rectum were re-contoured and the originally planned dose distribution re-calculated. Relative risk (RR) of radiation-induced cancer were calculated from the planned and re-calculated dose distributions by using the organ equivalent dose concept adapted to dose-response models reflecting varying degrees of cell sterilisation: a linear model, a linear-plateau model and a bell-shaped competition model.

Results: Using the competition model, the RRs of bladder cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7). Similar trends were seen for the RR for rectal cancer based on the pCTs ranged from 0.4 to 3.4, while a considerably wider range was found when including all rCTs (from 0.2 to 6.7).

Overall, the ranges were narrower with the linear model compared to competition model (Fig 1). For 4/8 patients for the bladder and 1/8 patients for the rectum, the estimated risks according to the competition model were consistently lower for IMPT compared to VMAT. Using the linear model the corresponding fractions were 6/8 and 7/8 patients. The remaining patients had rCTs with variations in RR, favouring either VMAT or IMPT, except one of the patients with all rCTs in favour of VMAT for rectal cancer using the competition model. In particular for the competition model, the RRs according to the pCT were often found at the upper or lower side of the RR across rCTs and two cases for bladder cancer and three cases for rectal cancer had RR <1 when addressed with the pCT but a median RR=1 across the rCT.