

Comparison of rectal dose-volume constraints for IMRT prostate treatment planning

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Abstract

The purpose of this paper is to compare different sets of rectal dose-volume constraints and to develop input criteria for the intensitymodulated radiation therapy (IMRT) of prostate cancer.

The IMRT treatment plans were created using Varian planning system (CadPlan with Helios module) for ten patients with localized prostate cancer (isocenter dose 78 Gy). The posterior portion of rectum was contoured as an extra volume (help volume). Three sets of input parameters for rectum with gradually increasing priorities (25-50-75-90) were designed for the inverse treatment planning : 1. dose-volume constraints allowing no more than 50, 40, 20, and 10% of the rectum volume be irradiated to 50, 60, 70, and 75 Gy, respectively – volume-based plans, priorities 25-90 (V25-90 plans) ; 2. maximum dose constraint of 74.1 Gy for rectum – plans with limited maximum rectal dose, priorities 25-90 (M25-90 plans) ; 3. maximum dose constraint of 50 Gy for the help volume – plans with limited maximum dose for the help volume, priorities 25-90 (H25-90 plans). Dose homogeneity in the planning target volume (PTV) and the rectal volumes (RV) irradiated to 50, 60, 70, and 75 Gy (RV 50-75 Gy) were recorded.

Rectum sparing improved for all the plans with increasing priority. While the M plans had the lowest RV 75 Gy values, the H plans gave the minimum RV 50-70 Gy values. Plans were considered acceptable if at least 98% of the PTV was treated to 95% of the prescribed dose. In particular plan groups, the V75, M75, and H50 plans, together with the V50 + M75 and H50 + M75 combined plans, satisfied this condition and yielded the lowest rectal doses. The H50 + M75 combined plan allowed optimal sparing of rectum (RV 50 Gy 51.6%, RV 60 Gy 38.5%, RV 70 Gy 26.0%, and RV 75 Gy 9.1%, respectively).

An optimal set of dose-based rectal constraints (maximum rectal dose 74.1 Gy, maximum help volume dose 50 Gy) has been developed for Varian planning software. These parameters will constitute a starting point for the prostate IMRT plan optimization.

KEYWORDS : Treatment planning, Optimization, Tissue response factors, Dose-volume analysis.

Testicular dose and associated risk from inverted-Y field irradiation in patients with Hodgkin's disease

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Abstract

This study aims to estimate testicular dose and the associated risks for infertility and hereditary effects from inverted-Y field irradiation. Radiotherapy was simulated on a humanoid phantom using a 6 MV photon beam. Testicular dose was measured for various field sizes and tissue thicknesses along beam axis using an ionization chamber. Gonadal dose was reduced by placing lead cups around the testes supplemented by a field edge block. For a tumor dose of 40 Gy, testicular dose was 0.56-6.52 Gy depending upon the field size and the distance from the inferior field edge. The corresponding dose to shielded testes was 0.12-1.96 Gy. The increase of tissue thickness increased the testicular dose up to 40%. An excess risk of hereditary disorders of (7-391) per 10000 births was calculated. The treatment parameters, the presence of gonad shield and the somatometric characteristics determine whether testicular dose can exceed 1 Gy, which allows a complete recovery of spermatogenesis.

KEYWORDS: Inverted-Y radiotherapy, Testicular dose, Infertility, Hereditary effects.

Original Paper

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In-vivo portal dosimetry by an Ionization Chamber

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Abstract

As all methods for *in-vivo* dosimetry require special efforts many physicists are often discouraged in verifying the middle dose in a patient along the beam central axis. This work reports a practical method for the determination of the middle dose value, D_m , on the central beam axis, using a signal S_t , obtained by a small thimble ion-chamber positioned at the center of the electronic portal imaging device, and irradiated by the X-ray beam transmitted through the patient. The use of a stable ion-chamber reduces many of the disadvantages associated to the use of diodes as their periodic recalibration and time consuming positioning. The method makes use of a set of correlation functions obtained by the S_t and D_m ratios, determined by irradiating a water-equivalent phantom with 6 MV, 10 MV and 15 MV X-ray beams. Several tests were carried out in phantoms with asymmetric inhomogeneities.

The method here proposed is based on the determination of the water-equivalent thickness of the patient, along the beam central axis, by the treatment planning system that makes use of the electron densities obtained by a computer tomography scanner, that works with calibrated Hounsfield numbers. This way, it is therefore possible to compare the dose, $D_{m,TPS}$, obtained by a treatment planning system, with the *in-vivo* dose D_m value, both defined at density middle point (identified along the beam central axis, where the thick material, in terms of $g\ cm^{-2}$, above and below, is the same).

The method has been applied for the *in-vivo* dosimetry of 30 patients, treated with conformed beams for pelvic tumor, checking: anterior-posterior or posterior-anterior irradiations and lateral-lateral irradiations. For every checked field at least five measurements were carried out.

Applying a correct quality assurance program based on the tests of the patient set-up, machine settings and calculations, results showed that the method is able to verify agreements between the dose $D_{m,TPS}$ and the in-vivo dose value D_m , within 4% for 95% of the 240 measurements carried out *in-vivo*.

KEYWORDS: *In-vivo* dosimetry, Portal dosimetry, Quality assurance dosimetry.

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The dependence of patient dose on factors relating to the technique and complexity of Interventional Cardiology procedures

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Abstract

Dose-area product (DAP) measurements were conducted for 168 coronary angiography (CA) and 89 single vessel percutaneous transluminal coronary angioplasty (PTCA) to examine the factors influencing patient dose beyond the X-ray exposure parameters. It was found that for CA, the DAP increases with the number of catheters used and with the number of vessels with stenosis. DAP values for patients with a prior bypass surgery, were higher compared to those without such a medical record to surgery. In PTCA, the use of coronary stents did not enhance the patient radiation dose significantly. Noticeable differences were found in the percentage contribution of each projection to the total DAP between the three types of single vessel PTCA. Finally low variations in DAP were found among the cardiologists performing both procedures.

KEYWORDS : Interventional Cardiology, Complexity, Radiation dose.

Technical Note

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A survey of patient doses from conventional diagnostic radiology examinations : first results from Serbia and Montenegro

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Abstract

Diagnostic reference levels provide framework to reduce variability. The aim of this study is to establish, for the first time, a baseline for national diagnostic reference levels in Serbia and Montenegro for the most common X-ray examination types. Measurements of patient dose using kerma-area product meter and entrance surface air kerma assessment were performed on at least ten patients for each examination type, in each of 16 randomly selected hospitals in Serbia and Montenegro, so that a total of 3,026 procedures for nine different examination categories were included in the survey. Exposure settings and individual data were recorded for each patient. Mean, median and third quartile values of patient doses are reported. Results have shown wide variation of mean hospital doses, with a factor of four for barium enema to 23 for thoracic spine radiography. Entrance surface air kerma were compared with previously published diagnostic reference levels (DRL) proposed by Commission of European Communities (CEC). Doses for all studied examination types except chest radiography were within European DRL. The reasons for dose variation are discussed. Survey data are aimed to help in development of an on-going national quality assurance and quality control programme in diagnostic radiology. The findings emphasize the importance of regular patient dose measurement to ensure that patient doses are kept as low as reasonable achievable.

KEYWORDS : X-ray examinations, Patient exposure, Effective dose, Radiation dose.