Effective beam directions using radiobiologically optimized IMRT of node positive breast cancer

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Abstract

The purpose of this study was to investigate the optimal coplanar beam directions when treating an early breast cancer with loco-regional lymphatic spread with a few radiobiologically optimized intensity modulated beams. Also to determine the increase in the probability of complication-free cure with the number of beam portals and the smallest number required to perform a close to optimal treatment for this tumour site.

Four test patients with stage II left-sided breast cancer were studied with heart, lung and contralateral breast as principal organs at risk. The clinical target volume consisted of the breast tissue remaining after surgery, the axillary, the internal mammary as well as the supraclavicular lymph nodes. Through an exhaustive search of all possible beam directions the most effective coplanar beams with one to four intensity modulated photon beam portals were investigated. Comparisons with uniform beam treatment techniques and up to 12 intensity modulated beams were also made. The different plans were optimized using the probability of complication-free tumour cure, P_+, as biological objective function.

When using two intensity modulated beam directions three major sets of suitable directions were identified denoted by A, P and T. A corresponds to an anterior oblique pair of beams around 25° and 325°, P is a perpendicular lateral pair at around 50° and 130° whereas T is a more conventional tangential pair at around 155° and 300°. Interestingly, these configurations identify simply three major effective beam directions namely at 30°±20°, 145°±20° and 310°±15°. For the three intensity modulated beam technique a combination of these three effective beam directions generally covered the global maximum of the probability of complication-free tumour control.

The improvement in complication-free cure probability with two optimally selected intensity modulated beams is around 10% when compared to a uniform beam technique with three to four beam portals. This increase is mainly due to a reduction by almost 1% in the probability of injury to the heart and an increase of 6% in the probability of local tumour control. When three or four biologically optimized beam portals are used a further increase in the probability of complication-free cure of about 6% can often be obtained. This improvement is caused by a small decrease in the probability of injury to the heart, left lung and other surrounding normal tissue, as well as a slight further increase in the probability of tumour control. The increase in the treatment outcome is minimal when more than four intensity modulated beams are employed. A small increase in dose homogeneity in the target volume and a slight decrease in the normal tissue volume receiving high dose may be seen, but without appreciably improving the complication-free cure probability.

For a stage II breast cancer, three and in more complex cases four optimally oriented beams are sufficient to reach close to the maximum probability of complication-free tumour control when biologically optimized intensity modulated dose delivery is used. Angle of incidence optimization may then be advantageous starting from the given most effective three beam directions.

KEYWORDS: Breast cancer, intensity modulation, biological treatment optimization, angle of incidence optimization.

Acceptance tests of Diagnostic Displays in a PACS System according to AAPM TG18

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Abstract

In a filmless environment it is necessary to execute acceptance and constancy tests on monitors used for interpretation of medical images. Performances of Barco CRT MGD521 MKII, Barco LCD Coronis and EIZO LCD L685EX monitors have been evaluated.

Acceptance tests were executed following AAPM Task Group 18 guidelines. Visual and instrumental evaluations of geometric distortions, reflections, luminance response, contrast, uniformity, resolution, angular response and veiling glare were made. Barco monitors showed optimal performances, while EIZO monitors were accepted with some reserve on their quality level.

Finally a comparative evaluation between monitors and film (the actual gold standard) was performed by an interview of ten radiologists; the monitors showed a quality at least equal to film. These monitors are currently in use for routine medical interpretation.

KEYWORDS: AAPM TG18, Display device, Calibration, PACS.

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Development of head docking device for linac-based radiosurgery with a Neptun 10 PC linac

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Abstract

Stereotactic radiosurgery is a method for focused irradiation of intracranial lesions. Linac-based radiosurgery is currently performed by two techniques: couch mounted and pedestal mounted. In the first technique a device is required to affix the patient's head to the couch and moreover to translate it accurately. Structure of such a device constructed by the authors plus acceptance test performed for evaluation is described in the article.

A head docking device has been designed and constructed according to geometry of linac's couch and also desired functions. The device is completely made from aluminum and consists of four major components: attachment bar, lower structure with four movements, upper structure with two movements equipped with a lock, two handles and a mounting ring for stereotactic frame. Translating accuracy, mechanical stability and isocentric accuracy were assessed in the frame of acceptance test.

Translating accuracy, mechanical stability and isocentric accuracy were found to be respectively: 1 mm, 1.64 mm and 3.2 mm with accuracy of 95%.

According to AAPM report no.54, a head docking device should translate head with an accuracy of 1 mm; this recommendation has been met. Moreover, we have demonstrated that the isocentric accuracy and mechanical stability of the device are sufficient that the device can confidently be used in stereotactic treatment.

KEYWORDS: Stereotactic radiosurgery, Head docking device, Translating accuracy, Mechanical stability.

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Preliminary Investigation on the use of the MOSFET Dosimeter in Proton Beams

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Abstract

Metal Oxide Semiconductor (MOS) device structures can be used to measure ionizing radiation through the mechanism of hole trapping in the oxide layer leading to changing of electrical characteristic of the device. They are a new type of direct reading semiconductor dosimeters. Due to their extremely small physical size, ability to permanently store the accumulated dose, dose-rate independence and their ease of use make them very promising for *in vivo* dosimetry. They are attractive for dosimetry in small radiation fields used in modern radiation oncology modalities, as conformal radiotherapy, IMRT, stereotactic radiotherapy / radiosurgery and proton therapy. Preliminary results on the use of commercial MOSFET dosimeters (TN-502RD, Thomson & Nielsen Electronics Ltd, Canada) irradiated on therapeutic 62 MeV proton beams are presented. Linearity with absorbed dose, sensibility and energy dependence were investigated. Moreover, the possibility to use of MOSFET dosimeters in order to measure the Output Factors (OF) for very small irradiation fields was verified. The comparison of OF obtained using MOSFETs and other dosimetry systems is reported.

KEYWORDS: MOSFET detector, Proton Dosimetry, Calibration curve, Output Factor.