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A manual Multileaf Collimator for use in Cobalt-60 Teletherapy

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Objective:

Multileaf Collimators (MLC) for conforming radiation fields to a target shape have been in use for more than 20 years. Despite the undisputed benefits and predominance of linear accelerators in radiation therapy, currently a total of 2344 Co-60 Teletherapy machines are still in use worldwide The quest for the application of modern technological advances in Co-60 radiotherapy that are standard in Linac radiotherapy - as, for instance, a MLC - has been mentioned frequently. This report presents the novel manual MLC* for conforming the beam of a Co-60 gantry based Teletherapy device to irregular field shapes.

* Prototype version of CobRaLeaf (Precisis AG, Heidelberg, Germany)

Methods and Materials:

For the special requirements present in many low-infrastructure environments, a manual MLC was developed to be used with a Co-60 Teletherapy machine. The main requirements for this collimator were defined to be a low costs, highly reliable, low maintenance, independent of electric power and versatile in its applicability. The maximum field size is 20*30cm2 in the isocentre. A novel drive mechanism for the individual leafs has been implemented by using a passive closed-loop, semi-automatically pneumatic system. A crossing bar enables the user to perform a single movement to return all leafs simultaneously to the outmost position. A unique clamping system applies lateral force to the leafs in order to eliminate interleaf leakage.

The MLC consists of thirty leaf pairs, made of 98mm of Brass and arranged in a fan-shaped setting (single-focus). The Co-60 source used in this experiment has a diameter of 15mm on a 80 cm SAD with an activity of the date of measurement of 59.4 TBq. Ion Chamber (IC) measurements and film dosimetry was performed to evaluate the collimators penumbra for various leaf end shapes and leakage properties.

Results and Conclusion:

A preliminary trial with a preceding model showed first results of the functionality and dosimetric properties. A survey among 16 users showed that the maximum field size of 20x30cm2 should account for approximately 80%-90% of the irradiated cases with a Co-60 machine. Penumbra (defined as 80%/20% region in depth of 10cm) for large fields (20 x 12 cm2) in direction of leaf movement was 8mm and 12mm for shaped and straight leaf ends,

respectively. The transversal penumbra was approximately 9 mm. Penumbra for the field of 10 x 10 cm2 showed a longitudinal penumbra of 6 mm and 7 mm for shaped and straight leaf ends, respectively. The transversal penumbra was 6 mm for this field.

No interleaf leakage was detectable.

The MLC presented in this report proves to be able to conform irregular fields in a Co-60 gantry-based Teletherapy device to any given isocentric shape within the given constraints. The lack of overtravel functionality and limited clearance can lead to restrictions in patient treatment that is to be improved in following prototypes. The novel design allows the use in a clinical workflow despite its independence from electronic drives. It is therefore expected to be well suited for the special requirements in low-infrastructure environments.

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MATERIAL DECOMPOSITION BY DUAL ENERGY COMPUTER TOMOGRAPHY (DECT)

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Objective: The physical basis of computer tomography is the attenuation of x-ray photon by the subject in the path of the x-ray beam. Quantitative computer tomography by scanning the same subject at two different energies can help us to characterize unknown material. To achieve this we have developed an inversion algorithm, in which the HU value of the same subject at two different energies are used as inputs for the inversion algorithm. This inversion gives the effective atomic number and electron density of the sample and with these two parameters, certain identification of the unknown material can be possible. We have carried out two sets of experiments. In the first set we scanned chemical compound with no effective atomic number and electron density. In order to evaluate inversion algorithm , in the second set if this inversion algorithm gets verified by this experiments then inversion algorithm can be applied for tissue characterization.

Methods and Materials: We prepared different mixtures of known concentrations of low effective atomic number chemical compound such as ethanol, methanol and acetic acid, with known composition. From the compositions the electron density (ρ_e) and the effective atomic numbers (Z_{eff}) of the mixture were calculated. These samples were filled in the test tube of the phantom. This test tube was fitted to the body of the phantom, while the phantom was filled with water.

We scanned the phantom, containing the chemical compounds (35 different compositions) at various energies, namely, 80, 100,120, 140 kvp. For each energy , one slice was selected with the ROI being taken at the centre of test tube and the corresponding HU value was read. The HU value of the sample at each of these energies was measured, to be used as an input in inversion algorithm and check the calibrations and inversion of the algorithms. The inversion algorithm tries to determine ρ_e and Z_{eff} by using two linear simultaneous equations.