

PS02.60 OPTIMIZING CONTOURING PROCESS IN RADIOTHERAPY: AI-POWERED AUTOMATION FOR ORGANS SEGMENTATION

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Introduction: Manual delineation of organs at risk (OARs) is crucial step for precise radiation delivery and radiation-induced toxicity. Recent artificial intelligence (AI) advancements offer a solution by reducing observer variability, adhering to guidelines, and improving accuracy of the contouring. Despite this, auto-segmentation is underutilized due to limited open-source frameworks for DICOM RT structure sets. The purpose of this study was to develop a custom software adapted to the needs of radiotherapy department.

Materials & Methods: Total Segmentator_v2 is nnUnet based on AI segmentation package available on GitHub capable of segmenting 117 structures. However, direct use in radiotherapy workflow is not possible due to requirements for data format conversion and not all the structures are appropriate for treatment planning. Due to this reason, a custom software based on Python programming language was developed and adapted to the needs of radiotherapy department.

Results: Using publicly available AI models, custom software tools were developed, allowing fully automatic segmentation and preparation of structure set. Depending on the scanned body area, up to 39 structures could be contoured in 4–6 minutes, providing significant time saving in comparison with manual segmentation. The nnUnet self-adapting neural network architecture, in conjunction with Total Segmentator_v2 software and additional Python functionalities, demonstrated high efficiency in the automated delineation process.

Summary: Implementing automated workflow, potentially were improved the efficiency and accuracy of delineation, paving the way for more precise and personalized treatment planning. Even publicly available AI-based segmentation tools could be successfully used for routine delineation, further clinical validation is necessary.

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PS02.61 ABSOLUTE LEAF POSITION VERIFICATION OF ELEKTA MULTI LEAF COLLIMATOR

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Introduction: In this work we present an absolute leaf position verification of Elekta multi leaf collimator (MLC) for quality assurance (QA) using electronic portal imaging detectors (EPID). EPID images are created using static and dynamic beams.

Materials & Methods: The QA process is based on reference EPID images taken at gantry and collimator angle 0°. For each measurement session, the following three methods for EPID image acquisition and position verification are utilized.

Method one uses a Picket Fence pattern generated with a static beam sequence with leaf travel in both directions. Method two uses a Picket Fence pattern which is generated by dynamic continuous leaf movement in both directions. For both methods, EPID images were acquired at four cardinal gantry angles. Method three uses different gantry movement during EPID picture acquisition. For each gantry movement, the second imaging method is used. Picket Fence patterns with deliberate errors are also acquired.

For leaf speed verification, method two and three were utilized with other dynamic beams.

The verification process of leaf position uses tolerances suggested by the 'Task Group 142: Quality assurance of medical accelerators' by Klein et al.

Results: Absolute leaf position verification and leaf speed verification has been done. Different methods and approaches have been used.

Summary: Different methods for EPID image acquisition have been deployed. Each data acquisition method's suitability for verification has been investigated. Integration of measurement procedure and data analysis into daily QA has been attempted.

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PS02.62 DEVELOPMENT OF METHODOLOGY FOR PRODUCTION OF IODINE-125 SOURCE FOR SKIN CANCER TREATMENT

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Introduction: Brachytherapy, also known as short-range therapy, uses precise doses for treatment. One of the most common radioisotopes used in brachytherapy is iodine-125, which emits low energy and is ideal for application in more superficial areas of the body, such as the skin, through flexible polymeric plates incorporated with this radioactive material.

Materials & Methods: Two silicone molds [Figure 1] are used to level the mixture made for the source fabrication. The radioactive material solution of iodine-125 (¹²⁵I) will be incorporated into cured resin, and studies will be conducted regarding its compatibility when mixed and leak tests (ISO 9978 standard) will be carried out [1].

Results: Implementation of a methodology for producing low dose rate brachytherapy flexible plates using the radioactive material ¹²⁵I produced at IEA-R1, where it will be incorporated into resin uniformly after evaluating its distribution and source sealability for skin cancer treatment.

Summary: Research to develop new technologies, products and services for the treatment of malignant diseases is extremely important to improve life expectancy and bring accessible innovations that reduce side effects for those affected.

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Appendix:

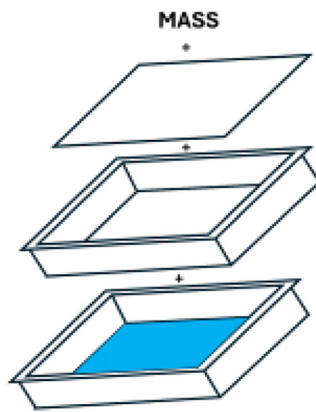


Figure 1: Perspective drawing of the overlapping of silicone molds. Source: Adapted from SILVA, J. T. 2021 [2].

References:

- [1] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. Radiation protection: Sealed sources leakage test methods. ISO: 9978:2020. 2 ed. p. 13. 2020. <https://www.iso.org/standard/70598.html>
- [2] SILVA JT. *Distribution and comparison by Monte Carlo Method of phosphorus-32 dose in polymeric plaques for the treatment of paraspinal and intracranial cancer*. University of São Paulo. 2021. <https://www.teses.usp.br/teses/disponiveis/85/85131/tde-09092022-155409/>

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PS02.63 DOSIMETRIC ANALYSIS OF THREE VOLUMETRIC MODULATED ARC THERAPY PLANS FOR PROSTATE CANCER

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Introduction: This study sets out to determine the dosimetric difference between three plans of Volumetric Modulated Arc Therapy (VMAT) by evaluating the dosimetric influence of increasing the number of arcs and using different collimator angles for prostate cancer.

Materials & Methods: We studied thirteen patients with prostate cancer, who received 76 Gy in 38 fractions in our center between 2017 and 2022. They were treated by VMAT technique with two, three or four Arcs. The photon beams were delivered by Varian UNIQUE™ linear accelerator. The treatment parameters are set as : two full arcs with collimator rotation (20° and 340°), three full arcs with collimator in (20°, 340° and 15°) and four full arcs with collimator rotated in (0°–90°), using an Eclipse treatment planning system. Different indexes were calculated as homogeneity index HI and conformity index CI and conformity number to compare and analyze the difference between the three VMAT plans.

Results: As a result, the three plans were clinically acceptable, but there were significant differences in the Monitor Units MUs. In fact, plans of 2 and 3 arcs reduced the monitor units from 809 to 494. The p value of D95% and D50% were < 0.05 in 4 arcs versus 3 and 2 arcs, indeed 4 arcs

conducted to ameliorated PTV parameters. The 4 arcs plan resulted also in decreasing V60% of bladder and rectum.

Key words: prostate cancer, radiotherapy, VMAT, HI, CI, p value.

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PS02.64 A FAST AND SIMPLE METHOD FOR MEASUREMENT OF MR- AND MV-ISOCENTER COINCIDENCE AT A LOW-FIELD MR-LINAC

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Introduction: For stereotactic radiotherapy with MR-Linacs the coincidence of MR- and MV-isocenter is crucial. Since phantoms from conventional radiotherapy usually do not provide MR signal, different phantoms and methods need to be developed. Current clinical procedures for MR- and MV-isocenter measurement are often labor-intensive and require re-positioning of the phantom used. The aim of this work was to develop a fast and simple method to measure MR- and MV-isocenter coincidence.

Materials & Methods: A 10 × 10 × 10 cm³ Winston-Lutz like phantom holding a tungsten-alloy sphere in its center was 3D printed and filled with silicone. Moreover, several geometric structures were inserted to allow for accurate positioning of the phantom. Radiochromic films [Ashland Inc., Wilmington, USA] were attached to the phantom and small PMMA slabs were used as backscatter material. The phantom was positioned via MR-imaging in the MR-isocenter of a low-field MR-Linac [ViewRay Inc., Oakwood, USA] and irradiated with rectangular fields from 90° and 180° beam angle. The films were scanned and the isocenters, i.e. the position of the radiation field (MV-isocenter) and the position of the sphere attenuation within the radiation field (MR-isocenter), were analyzed.

Results: The phantom is easy and quick to set-up and only one phantom position is needed to determine isocenter alignment in 3 dimensions. Backscatter material on top of the films is required to prevent radiation field blurring from electron return effects.

Summary: MR- and MV-isocenter coincidence of a low-field MR-Linac can be measured with a Winston-Lutz like phantom and radiochromic films.

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