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Clinical Use of the Software for the Automation of Treatment Field Parameters Verification Prior to Radiation Delivery

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Purpose: Verification of treatment field parameters by therapists take place prior to every or first fraction. Such verification or field timeout should be completely independent from record-and-verify system. It is performed manually via reading treatment parameters from linac screen and comparing them to treatment plan. We evaluate clinical use of software allowing automation of field timeout. **Methods:** The program for automated timeout performs three tasks.Plan information is extracted from PDF printouts generated by Eclipse (Varian Medical Systems, Palo Alto, CA) treatment planning system. User selects patient, plan and field to be compared with the field moded-up at the linac.Information from the Varian (Varian Medical Systems) linac's screen is extracted using video signal splitter and VGA2USB converter (Epiphan Systems, Ottawa, CA). Image farther undergoes character recognition, which works reliably for iX, Trilogy and 2100C linacs used in out tests.The plan and linac screen information are output to the computer screen and user is alerted if mismatch is observed. The software uses tolerances established in out clinic. The program also outputs auxiliary information, e.g. bolus, which is not well alerted by or can be omitted in the record and verify system.In the workflow tested, PDF printouts are uploaded for the software during second check and automatic timeout is performed for all treatments except v-sim and first fraction (of each treatment plan). **Results:** The software has friendly user interface and is easily included in clinical work flow. With the error rate being extremely low, we don't have data yet to claim that automated timeout provides higher safety than manual; however, it definitely cuts timeout time to 2-3sec per fields versus 10sec, if done manually. **Conclusions:** Field timeout automation is practicable and fits well into clinical workflow. It improves patient throughput and is expected to improve patient safety.
Conflict of interest: S. Kriminski and I. Lysiuk: provisional patent application is submitted to United States Patent and Trademark Office

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Evaluation of a 3D Patient Relevant Dose QA Tool: Multiple Institutional Studies

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Purpose: To evaluate 3DVHTM as a patient dose-verification and analysis tool through multiple institutional studies. Virtual patient doses were measured and compared among different vendors' treatment planning systems (TPS) and delivered by different vendors' LINACS so that we better understand the uncertainty of entire process within a patient undergone radiotherapy. **Methods:** One head-and-neck (H&N) and one lung patient were selected in this study. The DICOM images/RT structures along with clinical protocols including prescription doses (59.4Gy for H&N and 70.2Gy for lung) and normal-tissues tolerances were distributed to six institutions. Based on the same criteria, each institution generated their IMRT plans for the patients. Four different TPS and six different LINACS were used. The conventional per-beam IMRT QA using MapCHECK was performed by all participants. All the measured and calculated data were sent back to one institution for 3DVH analysis. Through the use of planned-dose-perturbation (PDP)TM algorithm (Sun Nuclear Corp.), the 'actual-DVHs' were generated and then compared to the 'reference-DVHs' from plans. Their differences represented errors induced from the combination of TPS dose-calculation algorithm and beam-delivery systems. **Results:** All plans in the study have met the clinical criteria. The 3D matching rates for 3%global/3mm (DD/DTA) ranged from 95.8-99.9% for H&N and 93.5-100% for lung. The dose-difference-histogram for PTV had a mean of 0.67% [0-2%] for H&N cases and 1% [0.6-2.8%] for lung cases. The QA tool was able to spot the doses outside 3%/3mm criteria for critical structures much easier than conventional planar QA methods. In addition, the hot/cold spots at the boundaries of collimators are attributed to the uncertainty of collimator-positioning greater than 1-mm. **Conclusions:** The analysis of IMRT plans in this study has shown that 3DVH is a vital QA tool for assessing clinically relevant doses as well as diagnosing potential systematic errors from both TPS and delivery systems.

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Arc Splitting for VMAT Patient QA

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Purpose: To determine the need for arc splitting for VMAT prostate patient quality assurance. **Methods:** Prior to Eclipse version 10.0, a verification plan for VMAT treatment could only be created which mirrored the clinical plan; if the plan called for a full arc, then the verification plan also contained a full arc. In this case, for a center that uses the Sun Nuclear MapCheck device with its Isocentric Mounting Fixture, the full fluence of an arc is delivered en face to the device. The question arose as to whether partial arcs, if they could be created, would fail a center's criteria, while the full arc passed them, in effect, whether there are cancellations occurring and not being observed. With Eclipse version 10.0, it is now possible to split a clinical arc into many subdivisions for verification; the software recommends no more than 40 partial arcs, for computing speed limitations. Twelve VMAT plans for prostate patients were investigated, in order to search for the aforementioned cancellations. Two full arcs were used clinically in all cases. Verification plans were created consisting of (1) the two full arcs; (2) 8 partial arcs of 90 degrees each; and (3) 16 partial arcs of 45 degrees each. These were all analyzed against our criteria of 3%/3mm with a threshold of 10%, and 95% of points passing. **Results:** Of 288 partial arcs and 49,670 points analyzed, there were a total of 100 points (0.2%) that failed the 3%/3mm criteria. No arcs, however, failed the 95% passing criteria. Moreover, there was no evidence of cancellation; if a point failed low, there was no corresponding high failure in another partial arc. **Conclusions:** In this study, splitting a full arc into partial arcs revealed no unseen failures.

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Design, Development, and Evaluation of a Modified, Anthropomorphic, Head, Quality Assurance Phantom for Use in Stereotactic Radiosurgery

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Purpose: To develop and evaluate a modified anthropomorphic head phantom for evaluation of stereotactic radiosurgery (SRS) dose planning and delivery. **Methods:** A phantom was constructed from a water equivalent, plastic, head-shaped shell. The original phantom design, with only a spherical target, was modified to include a nonspherical target (pituitary) and an adjacent organ at risk (OAR) (optic chiasm), within 2 mm, simulating the anatomy encountered when treating acromegaly. The target and OAR spatial proximity provided a more realistic treatment planning and dose delivery exercise. A separate dosimetry insert contained two TLD for absolute dosimetry and radiochromic film, in the sagittal and coronal planes, for relative dosimetry. The prescription was 25Gy to 90% of the GTV with <= 10% of the OAR volume receiving >= 8Gy. The modified phantom was used to test the rigor of the treatment planning process, dosimeter reproducibility, and measured dose delivery agreement with calculated doses using a Gamma Knife, CyberKnife, and linear accelerator based radiosurgery systems. **Results:** TLD results from multiple irradiations using either a CyberKnife or Gamma Knife agreed with the calculated target dose to within 4.7% with a maximum coefficient of variation of +/-2.0%. Gamma analysis in the coronal and sagittal film planes showed an average passing rate of 99.3% and 99.5% using +/-5%/3mm criteria, respectively. A treatment plan for linac delivery was developed meeting the prescription guidelines. Dosimeter reproducibility and dose delivery agreement for the linac is expected to have results similar to the results observed with the CyberKnife and Gamma Knife. **Conclusions:** A modified anatomically realistic SRS phantom was developed that provided a realistic clinical planning and delivery challenge that can be used to credential institutions