3108 Clinical Uncertainties and Corrections in using Removable SRS Head Frame

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Purpose/Objective(s): The uncertainty of using removable SRS frames was under emphasized. Although when using Brainlab SRS mask system, the 3D displacement of 3.17 mm was reported in a random trial, the discrepancies in most publications were within 2 mm. This study was designed to prospectively analyze clinical uncertainties of the current Brainlab removable SRS head frame; and evaluate the addition of a longitudinal strap in ensuring its geometrical accuracy.

Materials/Methods: From June of 2009 to March of 2010, a total of 26 intracranial lesions were treated with Brainlab SRS head mask system in our institute. The system consists of a back and front thermoplastic (AquaPlast) mashes; reinforcing pieces cross the forehead and upper lip attached by a nose bridge and bite pieces. The mask was routinely molded and dried for 15 minutes before re-attached to the patient before CT simulation. In the test group, a longitudinal strap was added to the mask, tightly extended cross the top of head. During treatment setup, the head was positioned against this longitudinal strap. The isocenter was first aligned with Brainlab SRS localization templates, and then confirmed with Varian’s CBCT.

Results: The absolute mean 3D displacement in the 16 cases using the commercial masks was 2.7 ± 1.5 mm. Their absolute means of vertical, longitudinal, and lateral shifts were 0.8 ± 0.8 mm, 2.3 ± 1.8 mm (p < 0.01), and 0.4 ± 0.5 mm respectively. The maximal 3D shift was 6.1 mm, basically caused by the longitudinal offset. The mean 3D shift of the 10 cases in the test group was 0.3 ± 0.5 mm (p < 0.01).

Discussion: All results were discounted the CBCT ± 1 mm uncertainty. Unlike a rigid test phantom, the uncertainty of the setup for real patients can be introduced by distortions of the AquaPlast mask, and the non-rigid surfaces of the patient head and face. The discomfort on the forehead for the tight mask instigates the head to shift inferiorly while raising the chin forward to fit into the mask. Since a small motion of lower jaw is permitted with this frame, longitudinal variation during often occurred without notice, unless advanced imaging modalities are used. The addition of a longitudinal strap provided superior limit for the head and significantly eliminated the uncertainty during setups.

Conclusions: The accuracy of current Brainlab SRS head mask system can be compromised often with an inferior shift. Well calibrated CBCT or other kV based imaging modalities shall be a standard confirmation tool in conjunction to a removable SRS frame. The addition of a longitudinal strap has demonstrated its effectiveness in ensuring the accuracy of Brainlab removable SRS head frame during clinical practice.

Author Disclosure: C.Y. Shang, None; C. Vargas, None; M. Kasper, None; A. Schramm, None; J. Sckolnik, None.

3109 Effect of Concurrent Hormone Therapy on the Positional Stability of Electromagnetic Transponders Implanted in the Prostate

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Purpose/Objective(s): Accurate localization of prostate gland using the Calypso System in external beam radiation therapy relies on the positional stability of the 2 to 3 electromagnetic transponders implanted in the prostate. Inter-transponder motion can be caused by transponder migration, prostate deformation or shrinkage of prostate. Patients on concurrent hormone therapy may experience substantial change in the volume of prostate over the treatment course. This study investigated the effect of concurrent hormone therapy on the positional stability of transponders.

Materials/Methods: Retrospectively, total eight prostate cancer patients who had been CT-scanned on the day of transponder implantation procedure were identified. Six of them were concurrently on hormone therapy while the other two were not. All patients completed 39 fractions of treatment to receive a total dose of 78 Gy. The inter-transponder distance (ITD) between the 3 implanted transponders of each patient was obtained from the CT scans on the day of implantation and measured by the Calypso System at subsequent radiation treatments. Changes in ITD relative to the day of implantation vs. the number of post-implant days were plotted over a period of 59 to 68 days. A trend line was constructed on each plot to smooth out random noises and fluctuation.

Results: The trend lines of ITD variation in all patients showed a more or less reduction in ITD post implantation. The most considerable ITD reductions appeared to occur within the first two weeks post implantation. The reduction magnitudes observed in this period were as large as 0.8 cm and were not found to have any correlation with the concurrent hormone therapy. Hence the reduction in ITD was primarily due to the resolving from prostate swelling. Beyond the first two weeks, ITDs in all patients appeared to become stable except for one transponder. ITDs varied within a narrow range of ± 0.1 cm to the end of treatment course. This degree of positional stability of transponders matched the findings in other studies performed on patients with no concurrent hormone therapy.

Conclusions: The positional stability of transponders in patients with concurrent hormone therapy in this study was found to match that observed in patients with no concurrent hormone therapy by other studies. The concurrent hormone therapy appears to have no significant effect on the positional stability of transponders though enrollment of more patients for further investigation is needed.

Author Disclosure: T.T. He, None; J. Tanyi, None; W. Laub, None; A. Hung, None.

3110 Preliminary Study and Clinical Application of Limited-angle Partial (LAP) Conebeam CT in Conventional Radiation Therapy

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Purpose/Objective(s): Determine the potential role of LAP CBCT in Patient Positioning in Radiation Therapy.
Materials/Methods: Limited-angle Partial (LAP) conebeam CT (CBCT) has been developed to position patients with various treatment sites such as prostate with seed implants, lung, head and neck with titanium implants, sarcoma patients with lower and upper extremities, and breast patient with boost plan. The LAP CBCT was implemented with Elekta XVI (version 3.5) and Synergy Linear Accelerator utilizing the following characteristics: S20 option (with two house-made smaller options), 200° scanning angles for breast, and 100° scanning angles for other sites. Various phantoms were fabricated to determine the optimum parameters of LAP CBCT in clinical applications.

Results: For breast, surgical clips were visible in three orthogonal planes even though the shape of the seroma was affected by other parts of the patient body. The surgical clips were found to be migrated by 4-8 mm for 8 consecutive patients treated with 3D CRT. The prostate patients with 4 seed implants, spinal SBRT, lung SBRT were involved to compare full CBCT with specific options for each treatment site (manufacturer-recommended option) and LAP CBCT. Geometrical differences between two techniques are 1-2 mm, which include the patient movements because of scanning time differences. For head and neck, with severe artifacts due to several implants, LAP CBCT introduces smaller artifacts for image fusion, even though the geometrical differences are on the order of inter-user- variations. For 3 sarcoma cases with setup of bent arms or thigh, patients’ skin is distorted due to insufficient scanning angles, thus CT wires onto the skin or the immobilization devices are used to position the patient. TLDs are used to measure the dose to the skin.

Conclusions: The LAP CBCT is taken in shorter scanning time, and gives smaller doses to other part of radiation-sensitive organs, lens, thyroid, and testes. Geometrical distortions (aliasing artifacts) due to insufficient scanning angles should be considered to understand the limitation of the LAP CBCT. It reduces the treatment time, and patient motion compared with full CBCT. Also, we can treat patients without moving the table during radiation delivery.

Author Disclosure: S.N. Huh, None; D. Indelicato, None; N. Xu, None; M. Ho, None; R. Malyapa, None; N. Mendenhall, None; Z. Li, None.

3111 Cobalt-60 Source Based Image Guidance in Broad Beam Cobalt-60 IMRT

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Purpose/Objective(s): Our previous research work has shown that a Cobalt-60 (Co-60) unit can be modernized to provide the potential for robust and reliable conformal and IMRT in both a tomotherapy and broad-beam setting. On-board image guidance is necessary to ensure tumor localization for precise conformal and IMRT treatment. Recent acquisition of an amorphous silicon (a-Si) imaging panel has enabled testing of broad beam imaging modalities using a Co-60 therapy unit. Imaging with the therapy source would provide a beam view while avoiding the requirement of an additional lower activity source or kV imaging system. Results to date clearly demonstrate that portal imaging, cone-beam computed tomography (CBCT), and digital tomosynthesis (DT) are feasible with a therapy Co-60 source and a-Si imaging panel. We have shown that DT has the potential to generate more useful depth information than portal images while delivering less dose than CBCT. In this paper, we illustrate the image guidance achievable with the Co-60 source and show the potential for Co-60 portal imaging, CBCT and DT in quantifying positional errors in patient set-up.

Materials/Methods: A PortalVision aS500 (Varian Medical Systems, Palo Alto, CA) a-Si imaging panel and Co-60 therapy source (Best Theratronics T780C, Kanata, ON) were used to acquire portal, CBCT and DT images of anthropomorphic phantoms with known set-up errors. Reconstruction of the CBCT and DT images was performed using an in-house implementation of the FDK filtered back-projection algorithm. DT reconstructions were performed using a subset of the projection images used for CBCT. The images were imported into a Varian Eclipse planning system (v 8.1.18) to utilize the image registration tools. Reference images from a CT Simulator (Philips Healthcare, Andover, MA) were registered to the respective Co-60 broad beam images to estimate position errors. DT images were treated as a subset of a volumetric CT and registered to selected views from the planning kVCT. In this initial work, only bony anatomy is considered for the anthropomorphic phantom position measurements.

Results: These modalities were used to successfully image an anthropomorphic chest, pelvis, and head phantom. Contrast and resolution were sufficient to determine phantom position using bony landmarks.

Conclusions: Image guidance is achievable using the treatment source on a cobalt therapy unit. The image quality is sufficient to enable simple registration based on bony anatomy. This work suggests that Co-60 units can be upgraded to provide some of the basic IGRT functionality expected of modern radiation units.

Author Disclosure: A. Kerr, None; N. Rawluk, None; A. MacDonald, None; M. Marsh, None; J. Schreiner, None; J. Darko, None.

3112 A Practical Strategy to Correct Prostate Reporting Rotated by a 4D Localization System

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Purpose/Objective(s): Beside the translational motion of the prostate, prostate rotation is also reported by the Calypso 4D localization system (Calypso Medical, Seattle, WA) during the external beam radiation treatment. Although large rotation angles have been observed for some patients no guidelines have been reported on how to deal with this information since it is often not possible to correct rotational changes using standard couches and sometimes large rotations are misrepresentations due to transponder migration. A practical procedure is described in this work based on our clinical experience and observations.

Materials/Methods: In our procedure portal images are taken at the first treatment if a >10 degree rotation angle is reported. Transponder alignments are checked between the portal images and the DRRs generated from the simulation CT. If all three transponders on the portal images are aligned with their contours on the DRR within an acceptable range, the treatment will continue. Otherwise, a simulation CT or Cone beam CT is suggested. By fusing the new CT with the old simulation CT based