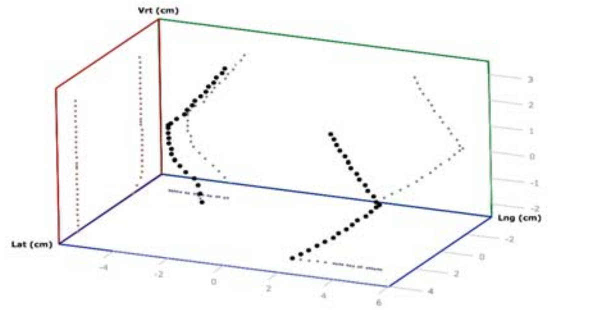
combination with the registration error, was evaluated. Independent translations and rotations, pairs of rotations, set of corrections obtained by arbitrary treated patients, maximum 3D range movement of Protura were also evaluated in other measurements.

Results: First step of the commissioning reports translational shift variations between simulated shift (Vrt, Lng, Lat) and the one obtained by the 3D3D matching, respectively (mean ± SD) 0.5±0.5 mm 0.6±0.5 mm 0.2±0.5 mm. Similarly for the rotation Pitch=0.05±0.05 ° Roll=0.12±0.15 ° Rtn=0.15±0.1°. Variations bigger than 1 mm and 0.1° between simulated and on robotic couch measured displacements was not observed.

In the second part, CBCT auto-match reproducibility reach a maximal variation of 1 mm and 0.2°. The overall translational positioning errors in terms of accuracy (defined as the mean of the absolute of the errors) were between 0.1 mm and 0.2 mm and between 0.0° and 0.1°. The gray value match resulted in slightly smaller errors than the bone match. For predefined rotational corrections with Protura, no significant difference can be seen in terms of the positioning error with the translational positioning accuracy in the range of 0.1 mm to 0.2 mm and a rotational one between 0.1° and 0.3°. Similar results were obtained for pairs of rotations and also for the clinical correction parameters.



Conclusions: A sub millimeter and sub degree positioning accuracy was found. In this context Protura is suitable in IGRT, even if, in the operational range evaluation, some areas were not reachable for the Protura alone. Further investigation will be carried out to optimize the operational range.

EP-1737

Geometric accuracy of 4DCT scans acquired using the wall and couch mounted variations of the Varian RPM camera system

B. O'Connell[1], C. McGarry[1]
[1]*Northern Ireland Cancer Centre, Radiotherapy Physics, Belfast, United Kingdom*

Purpose/Objective: Advances in 4DCT technology have led to its increased use in the delineation of targets for different radiotherapy treatment sites affected by respiratory motion. The maximum intensity projection (MIP), combined with individual breathing phase images, is used to delineate an integrated target volume representing motion over the full respiratory cycle. Accurate representation of anatomy in each breathing phase is essential for correct delineation of the target volume. The purpose of this work was to quantify differences in target delineation following 4DCT retrospective image acquisition on a CT scanner equipped with either a wall mounted or a couch mounted Varian RPM camera system.

Materials and Methods: Scans were acquired of the 4DCT imaging insert of the Modus Quasar phantom on a GE Lightspeed. Sinusoidal wave motion patterns were used to drive the phantom with periods of 2s, 4s and 6s and amplitudes of 1.5cm, 2.0cm and 2.5cm. The scans were acquired with rotation speeds of 0.5s and 1.0s using both the wall mounted and couch mounted camera setup. Each 4DCT scan was retrospectively sorted to generate the 0%-90% phase images in 10% intervals and the MIP using Advantage Sim 4D software and exported to Varian Eclipse treatment planning system v11.0. Volume contours of the 3cm x 3cm x 3cm block were generated using the CT ranger tool to include voxels with CT numbers greater than 20% above background. The sup-inf length of the cube was measured for each phase. These were then plotted against the maximum velocity of the cube within each phase. A comparison was made between wall mounted and couch mounted versions using a paired t-test.

Results: No significant difference in cube lengths was found for images acquired on a scanner with either a wall mounted or couch mounted scanner (p=0.733). Figure 1 shows that the measured cube length is highly dependent on the maximum phase velocity and the scan rotation speed. Measured cube lengths were closer to the actual 3cm length when the scan rotation speed was increased to 0.5s (p<0.01). Significant deviations from the sinusoidal pattern were observed in breathing traces using the wall mounted camera but not with the couch based camera. This may lead to errors in the required identification of peaks in the breathing cycle. The MIP derived cube lengths were all within 3mm of the expected lengths.

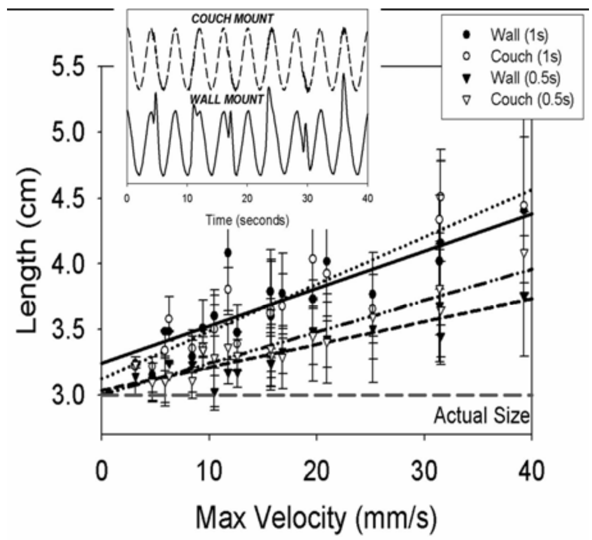


Figure 1: Recorded imaging cube length versus maximum phase velocity for 4DCT scans aquired with wall mounted and couch mounted RPM cameras with 0.5s and 1.0s scan rotation times. Top insert: Sinusoidal breathing traces recorded with couch mounted and wall mounted cameras.

Conclusions: No significant difference was found in geometric accuracy between 4DCT scans acquired using wall mounted and couch mounted RPM cameras. However, the scan accuracy is dependent on the identification of peaks within the recorded breathing trace. The breathing trace recorded using the wall mounted system displays couch motion induced errors which may lead to the misidentification of peaks resulting in image artefacts. It was found that 4DCT scans acquired with the maximum tube rotation speed of 0.5s are more geometrically accurate than scans acquired with 1.0s rotation speeds.

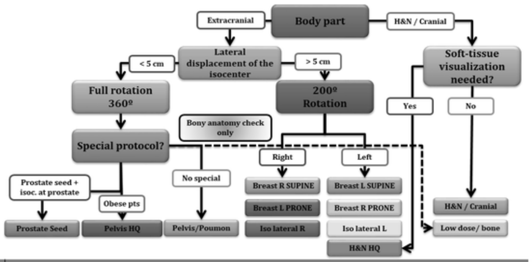
EP-1738

Streamlined clinical CBCT protocols: Reduced dose and variation and maintained image quality

M. Devillers[1], F. Lakosi[1], L. Janvary[1], S. Ben Mustapha[1], E. Lenaerts[1], P. Coucke[1], A. Gulyban[1]
[1]*Liege University Hospital, Department of Radiation Oncology, Liege, Belgium*

Purpose/Objective: To investigate strategies to simplify the pre-defined conebeam CT (CBCT)protocols for clinical workflow meanwhile reduce dose without compromising image quality.

Materials and Methods: The doses of the pre-defined thirteen CBCT protocols were measured using the Computer tomography dose index (CTDI) with dedicated body and head phantoms at our Elekta Synergy equipped with XVI (version 4.2). Additionally the CTDI reduction of each parameters were identified: the application of bow-tie filter, changing from medium to small panel position, using collimation by the 20, 15 or 10 cassettes and to change mA per frame between 64, 40 and 24. No alteration was applied for number of frames or for kVp. Image quality was tested, using the Catphan 503 phantom with visual and quantitative comparisons. Reduction of the large variation of existing CBCT protocols were proposed giving a recommendation for any possible clinical scenarios by a decision making tree (Figure 1).



	F1 filter					
	M10	M20 (2 minutes)		S20 (1 minute)		
	12 mGy	28 mGy	17 mGy	12 mGy (H&N HQ 17 mGy)		1 mGy
Start	181			21	340	340
Stop	180			181	180	180
Rotation	↩			↪	↩	↩

Figure1. Decision making tree and corresponding CBCT parameters.

Results: The pre-defined CBCT protocols resulted in median CTDI of 28 mGy (range:19-44 mGy) for body and 1.5 mGy (1.2-1.8 mGy) for head phantoms respectively. The average CTDI reduction were 39% by bow-tie filter, 29% by small instead of medium panel position, 41% and 62% by using 40 mA and 25 mA compared to 64 mA and 8% and 28% by 15 and 10 compared to 20 cassette. The image quality does not suffer detonation compared to the original protocols. Finally six CBCT protocols were established to cover all possible clinical situations with the median CTDI of 14 mGy (range: 12-28 mGy) for body and 1 mGy for the head phantoms. The clinical introduction of the new CBCT protocols were smooth and to date no alteration was requested.

Conclusions: Reduction of CTDI and large variation of CBCT protocols are feasible, by applying bow-tie filter for all protocols. Reducing mA per frame from 64 or 40 to 24 mA did not show detectable detonation in terms of image quality. Furthermore with proper selection the reduced number of protocols still covering all clinical situations without the need for further adjustment.

EP-1739

Analysis of a stereotactic frameless radiosurgery technique for targeting arteriovenous malformation

F. Steenbeke[1], T. Gevaert[1], K. Poels[1], D. Verellen[1], J. D'Haens[2], F. Van Tussenbroek[3], M. De Ridder[1]
[1]Universitair Ziekenhuis Brussel, Radiation Oncology, Brussels, Belgium
[2]Universitair Ziekenhuis Brussel, Neurosurgery, Brussels, Belgium
[3]Universitair Ziekenhuis Brussel, Radiology, Brussels, Belgium

Purpose/Objective: Stereotactic radiosurgery (SRS) has become a well-established treatment technique for cerebral arteriovenous malformations (AVM). Delineation of the nidus for SRS treatment planning takes place on biplanar digitally subtracted angiography (DSA). These images provide sufficient temporal and spatial resolution in two dimensions (2D). A stereotactic frame is needed to transfer the contour from DSA to planning computed tomography (CT).To move from the "so called" frame-based approach, a registration algorithm is needed to replace the localizer box. The DSA (2D) datasets must be registered anatomically with the CT (3D). The aim of this study is to evaluate the targeting accuracy of an open-access application, AngioFusion (Gorlachev G.E.,Moscow, Russia), for image registration and target delineation.

Materials and Methods: Thirty patients, who underwent frame-based SRS at our department, were retrospectively analyzed. CT and DSA (coronal and sagittal) images were imported into the application after which a digitally reconstructed radiograph (DRR) of the CT was generated. The DSA images were registered with the DRR by shifting the DRR in 7 dimensions (3 translations, 3 rotations and source detector distance) towards the DSA. Contouring of the AVM was started after visual acceptance of the image registration. Objects drawn on one DSA image are automatically projected on all other images and vice versa (Figure 1). Contours are exported in DICOM RTSTRUCT format and imported into Brainscan 5.32 (Brainlab AG, Feldkirchen, Germany) where the initial treatment planning was performed. The isocentric coordinates (anterio-posterior (AP), latero-lateral (LAT) and cranio-caudal (CC)) of the AVM in frameless (AngioFusion) and frame-based (initial treatment) mode were compared against each other.

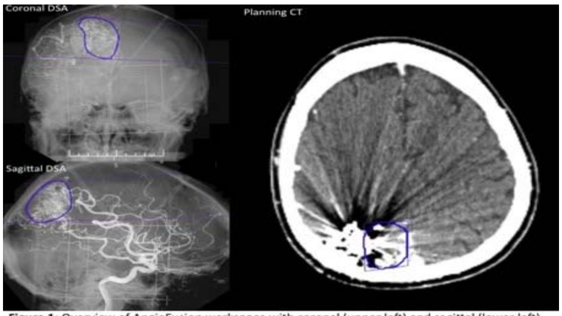


Figure 1: Overview of AngioFusion workspace with coronal (upper left) and sagittal (lower left) DSA datasets registrated with the planning CT (right). Contours drawn on one imageset is automatically projected on the other data sets.

Results: The targeting accuracy of this frameless image based application for target delineation can be estimated from retrospective analysis of patients with DSA and CT datasets with localizer box. The image registration between both datasets can be properly performed when using DICOM information of the coronal and sagittal DSA image sets. In this way, rotations, zoom factor and SDD can be manually introduced into the software to start the registration. Automatic registration can be used but requires that the datasets are already in close vicinity. Manual adjustments were necessary in order to get the best registration based on bony anatomy of the skull. Comparable targeting accuracy between the frame-based and frameless approach was found with an average difference of 0.59±0.34 mm, 1.04±0.36 mm and 0.87±0.79 mm for the AP, LAT and CC directions respectively.

Conclusions: Our preliminary results show the feasibility to perform image registration of 2D DSA and 3D CT datasets for delineation and targeting for AVM SRS. Retrospective analysis of 30 patients shows good targeting accuracy comparable to the frame-based approach, which is up to now the golden standard.

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EP-1740

The impact of the CT scanner calibration curve on the calculation of dose distribution

B. Pawalowski[1], S. Adamczyk[1], M. Adamczyk[1]
[1]Greater Poland Cancer Centre, Medical Physics Department, Poznan, Poland

Purpose/Objective: The purpose of this work was to investigate the impact of used CT scanner calibration curve on the dose distribution calculations in a treatment planning system.

Materials and Methods: The treatment planning system for the dose distribution calculation needs to convert DICOM image expressed in Hounsfield scale to information in electron density unit. Eclipse TPS from Varian implements calibration curve defined in ICRU 42 which is by default assigned to each new CT scanner. However, there is a possibility to create individual calibration curve for each scanner using measurements performed in phantom with inserts of different materials (with well-known electron density). Ten different IMRT and 3DCRT plans were created on the scans of anthropomorphic phantom using demanding planning requirements. For each of this cases TPS used default calibration curve. The number of beams in a treatment plan was varied from four to seven. Then, using special phantom with rods build from material with different electron density, authors prepared a real calibration curve for CT scanner SIEMENS DEFINITION AS. After that each plan was realized with 6 MV photon beam quality on Clinac 2300CD/S and the dose distribution was measured by Gafchromic EBT. Next, a new calibration curve was implemented in TPS and the same plans were recalculated with constant MU number. One measured and two planned dose distribution exported from TPS (one with an default calibration curve and one with new calibration curve) were compared based on the Gamma Index (γ) analysis with common use criteria of distance to agreement DTA=3mm and dose difference ΔD=3% (with reference to the maximum dose).The scoring parameter was the percentage of the field area (defined by the threshold of 5% from the maximum dose value) resulting with $\gamma \leq 1$ (score).

Results: All studied plans were clinically acceptable. In each case significant impact of calibration curve used was observed. The measured dose distribution is more comparable with the dose distribution calculated based on new calibration curve. Gamma and dose difference were calculated for all fields. Table 1 presents selected results. Every