Evaluation of a multi-atlas based automatic segmentation using majority voting approach for treatment planning

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Purpose/Objective: The atlas-based automatic segmentation can significantly reduce contouring time. A multi-atlas method has been shown to provide greater accuracy than a single best matched (SBM) method. In this work, we evaluated the multi-atlas based segmentation using majority voting approach for head and neck (H&N) and prostate cancer.

Materials and Methods: 50 prostate atlases and 20 H&N atlases were developed and utilized for atlas-based segmentation. Prostate atlas contained CT images and manually defined contours of the prostate, seminal vesicles, rectum and bladder. H&N atlas contained CT images and manually defined contours of the brain stem, spinal cord, parotids, constrictor muscle, larynx, oral cavity and thyroid. SBM used one automatically selected best match atlas. Multi-atlas used multiple automatically selected best matches (3, 4, 5, and 10, respectively). And, the final segmentation fused the individual segmentations using majority vote rule. We performed automatic segmentation using SBM and multi-atlas for 10 prostate subjects and 10 H&N subjects. Average dice coefficients were calculated for each structure to compare against manually defined contours for subjects.

Results: In prostate case, average dice coefficients of multi-atlas (3, 4, 5, and 10) and SBM were 0.686 ± 0.192, 0.693 ± 0.192, 0.716 ± 0.208, 0.768 ± 0.141 and 0.650 ± 0.182, respectively. There was a statistically significant difference between SBM and multi-atlas: 10 (P = 0.0014). In H&N case, average dice coefficients of multi-atlas (3, 4, 5, and 10) and SBM were 0.709 ± 0.176, 0.737 ± 0.159, 0.740 ± 0.157, 0.757 ± 0.132 and 0.715 ± 0.166, respectively. There was a statistically significant difference between SBM and multi-atlas: 10 (P = 0.0062).

Conclusions: The multi-atlas based segmentation using majority voting was greater accuracy than SBM for H&N and prostate cancer. The multi-atlas based segmentation was more accurate with increasing the number of fused atlas.

PO-0811

From 3D conformal to TomoDirect™ modality treatment for the postoperative breast radiotherapy

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Purpose/Objective: To compare the TomoTherapy® System's TomoDirect™ modality to the standard 3DRT technique for the postoperative breast radiotherapy.

Materials and Methods: We compared the treatment plans of 30 patients consecutively treated from February to May 2012 with the new TomoTherapy® System's TomoDirect™ (TD) modality for postoperative breast radiotherapy. The TomoDirect™ was implemented in our Institute from January 2012. Clinical target volumes (CTV) and organs at risk (OAR) were contoured for all the patients by the same physician to avoid interobserver variability; a PTV was generated by adding a 5 mm uniform margin to the CTV. Patients underwent the whole breast irradiation and a simultaneous integrated boost to the tumor bed region. The prescribed doses (at the 95% isodose) were 2.25-2.50 Gy/fraction up to a total dose of 45-50 Gy (20 fractions) to the whole breast and to the postsurgical area respectively. Plans for TD and 3DRT were both optimized, according to our Intitutional protocol, in terms of dose coverage to target and constraints. The constraints routinely used refer to a dose of 2Gy/fraction andare: PTV(breast), V95%≥95%, D50%£108%, V100%(boost dose)£30%, Dmax£115%; PTV(boost), V95%≥95%, Dmax<115%; Heart (right breast),Dmax<16-20Gy,V8Gy<10-15%; Heart (left breast), D5%<16-20Gy,V8Gy<30-35%;Heart (right/left breast) Dmean<3.2-4Gy; Ipsilateral lung V16Gy<15-20%,V8Gy<35-40%, V4Gy<50%, Controlateral lung V4Gy<10-15%;Controlateral breast Dmax<2.4-2.6Gy.

Results: The dosimetric comparison related to the PTVs and to the OARs DVHs are reported in the Table as mean values (%) plus/minus the standard deviation (%). Controlateral breast maximum dose resulted: 2.9±2.6Gy, 2.5±2.2Gy for 3DCRT andTD respectively, while Controlateral lung maximum dose is about 0 Gy in both cases. Concerning the treatment time and the planned monitor units, the firsts where378±55s and 95±15s while the monitor units were 5199±822 and 278±13 in the in the TD and 3DRT cases respectively.

Constraints/ OAR	V95% 3DRT	V95% TD	D50% 3DRT	D50% TD	Dmax 3DRT	Dmax TD	V100 dose of boost 3D	V100 dose of boost TD
PTV(breast)	96.1±2.8%	99.2±1.3%	102.2±2.7%	101.9±2.0%	115.6±2.0%	114.3±2.2%	6.9±5.6%	0±1%
PTV(boost)	99.3±6.1%	100.0±21.1%			106.6±6.2%	107.0±6.3%		
Ipsilateral Lung	V16Gy 3DRT	V16Gy TD	V8Gy 3DRT	V8Gy TD	V4Gy 3DRT	V4Gy TD		
	10.0±4.8%	13.2±3.9%	13.3±5.7%	17.0±4.3%	31.0±9.1%	23.5±7.5%		
Heart (left breast)	D5% 3DRT	D5% TD	V8Gy 3DRT	V8Gy TD	Dmean 3DRT	Dmean TD		
	6.2±3.4%	5.0±4.8%	3.0±2.1%	2.9±2.5%	3.0±1.1%	2.0±0.9%		

Conclusions: TD was investigated as an alternative technique to the 3D conformal one for the postoperative breast radiotherapy. DVHs show an improvements in PTV coverage and Heart sparing. On the contrary, the treatment time and the monitor units of the TD technique are about 4 and 18 times those of the 3DRT. The real advantage of the TomoDirect™ is the possibility of performing the image guided radiotherapy and in this case results suggest that the use of the TD technique is definitely favourable.

PO-0812

Critical appraisal of VMAT compared to electrons for cutaneous Kaposiis sarcoma of lower extremities treatments

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Purpose/Objective: To investigate the advanced radiotherapy treatments of cutaneous Kaposi's sarcoma of lower extremities with adequate target coverage and bone high sparing with volumetric modulated arc therapy (VMAT, RapidArc (RA)) in comparison to electron beams.

Materials and Methods: Ten patients were planned with RA and, alternatively, with electron beams. Patients presented superficial target volumes adjacent to the leg's bones and extending from the knees to the base of the foot in 7out of 10. Target volume longitudinal length was in average 45±12cm (range 29-66 cm). Dose was prescribed to 30Gy in 10 fractions to mean planning target volume (PTV), and significant maximum dose to the bone was limited to 30Gy. Plans were designed for 6MV photon beams for RA and 6MeV for electrons. For RA two groups of plans were generated: the first, RA_1, with the aim of respecting planning objectives for target coverage, homogeneity and maximum dose to the bones, the second group, RA_2,was generated adding the request to maximise bone sparing without significant compromises to target objectives. Dose distributions were computed with AcurosXB for photons and with Monte Carlo for the electrons.

Results: Given the specificity of the target, PTV coverage was acceptably for both RA_1 ($V_{95\%}$>95%,$V_{107\%}$<0.5%) and RA_2 plans ($V_{90\%}$>95% $V_{107\%}$<5.0%) respecting the objective of a bone sparing with $D_{2\%}$<30Gy, while, although acceptable for bone involvement, pronounced target coverage violations were obtained for electron plans. MU resulted comparable for electrons and RA although the latter increased when a superior bone sparing was imposed, reaching, however, a significant improvement also respect electrons plans on all the analyzed parameters for bone DVHs ($D_{2\%}$, D_{10cm3} and D_{20cm3}, and V_x with x=10, 20, 30Gy, mean dose). Delivery time were 12.1±4.0 minutes for electrons and 4.8±1.3 minutes for the most modulated RA plans (RA_2).

Conclusions: High plan quality was shown for Kaposi sarcoma in the lower extremities using VMAT and this might simplify the management of these treatments in comparison to more conventional usage of electrons, particularly in institutes with limited staff resources and heavy workloads. In addition, VMAT demonstrated dosimetrically extremely advantageous and a flexible approach also in a typology of treatments where electron beam therapy is mainly considered to be effective due to the limited penetration of the beams.

PO-0813

Use of radiobiological endpoints to compare treatment planning techniques for pancreatic cancer

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