small. VMAT is a well suited technique with shorter treatment time but HT plans have better HI than VMAT.

EP-1696

Can we increase the dose with particle therapy versus IMRT? A dosimetric study for sinonasal cancer

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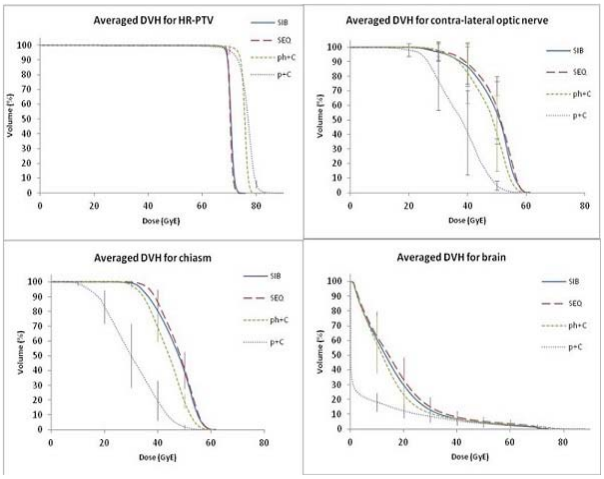
Purpose or Objective: Dosimetric comparison among treatment plans from different RT techniques (photons, protons and carbon ions) within a prospective multicentric trial aiming at the evaluation of the impact of combined treatment modalities on target coverage and OARs sparing for sinonasal tumors.

Material and Methods: High risk PTV (HR-PTV), which comprised gross disease, and low risk volume (LR-PTV), with elective neck, were defined for 5 pts. Four treatment plans were generated for each pt: a pure sequential (SEQ) and a pure SIB photon plan, a particle sequential plan with protons and carbon ion boost (p+C) and a combined plan with photons and carbon ion boost (ph+C). Prescription doses (PD) to HR-PTV were 70 Gy (2 Gy/die) for photon plans and 75 GyE for plans with a carbon ion boost (21 GyE in 7 frs). PD to LR-PTV were 56 Gy (1.6 Gy/die) for SIB modality and 54 Gy (2 Gy/die) for sequential plans. Varian Eclipse TPS was used to optimize VMAT photon plans with coplanar and non-coplanar arcs. Particle plans were calculated using Siemens Syngo TPS and IMPT optimization strategy. The highest priority during optimization was given to spare neurological structures, followed by PTVs coverage and then remaining OARs. A dedicated software (VODCA, MSS Medical Software Solution GmbH, Switzerland) was used to sum up photon and particle plans and to compare DVHs from different approaches. We considered different parameters: the most significant for PTVs coverage were volume encompassed by 70 Gy isodose (V70Gy), conformity index and homogeneity index. As for OARs, V10Gy was reported for temporal lobes, brain and mean dose (Dmean) for contra-lateral optic nerve, chiasm, cord, brainstem, cochleae. Integral dose was recorded to evaluate healthy tissue (HT, patient volume minus larger PTV). Differences in techniques were analyzed by paired Student's 2-sided t-tests for each dosimetric parameter, taking p-value <0.05 as statistically significant.

Results: All plans could be considered clinically acceptable. The photon ones showed a better conformality and homogeneity for HR-PTV against p+C plans. Although minimum dose (as percentage of PD) was higher for photon plans, V70Gy was statistically relevant in favor of p+C plans vs the other modalities. Despite a higher PD for plans with carbon ion boost, a significant advantage on some OARs was recorded: Dmean in p+C plans was significantly lower for contra-lateral optic nerve, chiasm and cochleae, as it is V10Gy for temporal lobes and brain. This finding was reinforced by a statistically significant difference in integral dose for p+C plans vs the others, but also for ph+C plans vs SIB. See averaged DVHs in Fig. 1.



Conclusion: Although less homogeneous and conformed, particle plans allow a higher PD to HR-PTV compared to photons. Due to their specific physical characteristics, combined particle treatments can potentially better spare OARs and HT in terms of intermediate and low doses.

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Evaluating patient dose difference in case of linac transfer under treatment

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Purpose or Objective: To allow or not the patient transfer between 2 energy-matched Linacs, differing only by their MLC generation, in case of breakdown.

Material and Methods: Two linacs were beforehand matched in terms of energy (TPR20,10) and each separate calculation model in the TPS validated. This retrospective comparison was performed with the calculated dose from the TPS to assess the impact of transferring a patient from one machine to another, for some fractions (n=1 to 5) over the whole treatment (N fractions). One should note that 3D plan verification failed in general if the measurements occurs on the wrong machine.
Fifty VMAT plans were studied (head & neck , whole brain, rectum, prostate, other; 10 plans of each), corresponding to 60 PTVs and 100 OARs. Dose was re-computed with the non-planned machine, without any optimization, if up to n=5 fractions are transferred.
Reported dose-metrics (see ICRU-83) are Dmean (mean dose), Dmax (max dose), D95% and HI (homogeneity index) for all ROIs, and well-known parameters are used for some OARs, depending of OAR type (V20, V74,...). Each parameter is expressed as relative to the initial planned treatment.

Results: There is a systematic over-dose delivering when transferring a patient from the "new generation" Linac (Mnew) to the "old" one (Mold). The opposite is checked.
Dmean and Dmax variations are linearly dependent of the number of transferred fractions (R^2=0.91), for PTVs and OARs. No linear correlation could be found for others metrics, which seem to strongly depend on each anatomy.
Variations are always more important for OARs than for PTVs.
The maximum difference was found as the Dmean on a right femur for a rectum treatment (11.4%). This value is increased to 15% and set as the maximum available for n=5.

Conclusion: Dose differences are here mainly due to thickness variations of MLC leaves, over other design improvements (leaf profiles, rounded leaf ends,...), as dose variation is related to leaf thickness and OARs are on the other hand more affected by linac transfer than PTVs (protected ROIs are more often under leaves than targets).

The linear correlation between Dmax (or Dmean) and n associated to a maximum variation achievable leads to an empiric formula predicting how much the dose metrics will be affected, in case of a transfer from Mnew to Mold, without recalculating the whole plan (see eq.). This can be easily reversed.

$$D_{max|mean}^{initial} \leqslant D_{max|mean}^{final} \leqslant \frac{N+0.75n}{N} D_{max|mean}^{initial}$$

This conclusion must be obviously applied only for N≥10 (then excluding SRS/SBRT).

EP-1698

New sliding window IMRT planning design for head and neck patients with dental prostheses.

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Purpose or Objective : A percentage of patients receiving head and neck radiotherapy treatments wear dental prostheses: implants or dental fillings. The high atomic number composition of this prostheses, most of times unknown, results in a possible inaccurate dose calculation.
The purpose of this study is to develop a method for minimize dosimetric alterations caused by prostheses of unknown composition, preventing radiation beams passing through them.

Material and Methods: Varian Medical Systems, Palo Alto, CA: TPS Eclipse with IMRToptimization "Dose Volumen Optimizer" version 10.0.28 and dosecalculation algorithm "Analytical Anisotropic Algorithm" version10.0.28. The images, contoured volumes and prescriptions of two patients treatedin clinical routine are used (Table I).
Steps to be followed:
1. From images of each patient, identifyand outline the prostheses. Also contour the artefacted region and overwrite HUto the HU of the surrounding tissue.
2. Create a sliding window IMRTplan with slightly (<10º) modified conventional gantry angles (7-9 fields inour centre) to minimize incidence upon prostheses and optimize dosimetry asusual. This plan is called REFERENCE PLAN.
3. Copy the REFERENCE PLAN. The twoor three fields that pass through the prosthesis before entering the PTV areselected, and in each field the area of the incident fluence on the prosthesesis removed using the editing fluence tool available in our TPS (Figure 1). Removethe remaining fields. This result from two or three fields with partiallyerased fluences is called the BASE PLAN.
4. Create a new plan with theremaining angles present in the REFERENCE PLAN but not in the BASE PLAN. Optimizethis plan to fulfil the prescription considering the dose contribution of theBASE PLAN. This is called the SUPPLEMENT PLAN.
The treatment plan is the sum of the BASE PLAN and SUPPLEMENT PLAN .
With this method the achieved dosimetry hasn't an increased dosecalculation uncertainty due to the presence of materials of high atomicnumbers. Nevertheless, the dosimetry obtained in this way could cause a loss ofquality in terms of PTV coverage or higher doses to organs at risk. Therefore,it is compared to a regular dosimetry (7-9 field same espaced), in which thepresence of the prosthesis was not taken into account.
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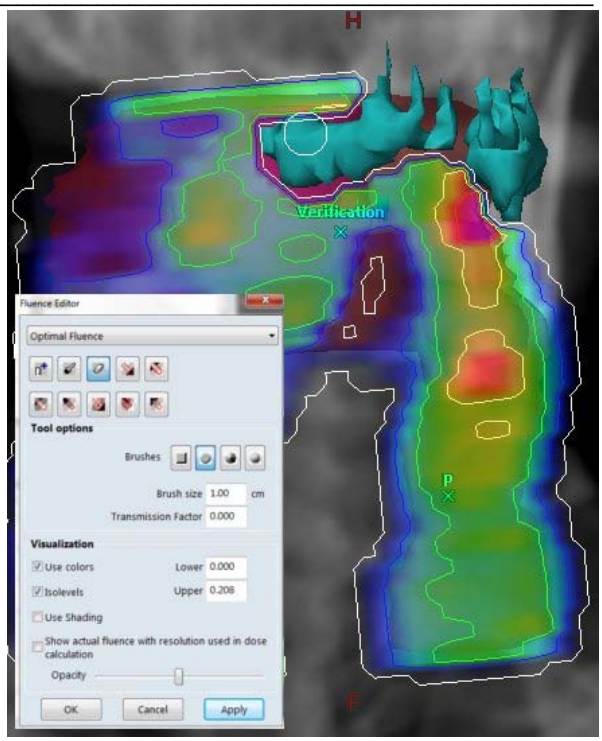

Results: Table I shows the dosimetric parameters comparison between new planning design proposed and usual design regardless of prosthesis. The absorbed dose distributions in the PTVs are similar in both cases. Regarding organs at risk, there are no significative differences in spinal cord, dose to parotids are increased up to a 20% in the new design.

TABLE I. ABSORBED DOSE FOR PTV AND OAR

	Patient 1		Patient 2	
	Conventinal Design	*New Design*	*Conventinal Design*	*New Design*
Prescribed Dose(PTVN)(Gy)	52.8	52.8	54.1	54.1
$D_{98\%}$(PTVN)(Gy)	50.6	50.3	51.95	51.9
$D_{50\%}$(PTVN)(Gy)	54.5	53.6	57.0	58.5
$D_{2\%}$(PTVN)(Gy)	71.0	73.3	73.3	74.6
Prescribed Dose(PTVT)(Gy)	70.0	70.0	70.0	70.0
$D_{98\%}$(PTVT)(Gy)	65.2	65.7	65.4	65.7
$D_{50\%}$(PTVT)(Gy)	69.5	71.3	70.9	71.2
$D_{2\%}$(PTVT)(Gy)	72.6	74.8	73.8	75.0
$D_{50\%}$(ParotidR)(Gy)	11.6	11.6	19.9	21.9
$D_{50\%}$(ParotidL)(Gy)	28.9	34.7	17.6	20.1
$D_{2\%}$(Spinal Cord)(Gy)	39.8	36.4	43.1	42.5
$D_{2\%}$(PRVSpinal Cord)(Gy)	41.6	37.8	45.3	45.2
Volume(PTVN)(cm^3)	332.8	332.8	435.0	435.0
Volume(PTVT)(cm^3)	32.3	32.3	130.3	130.3
Volume(prostheses)(cm^3)	1.6	1.6	12.1	12.1
CI(PTVN)	1.52	1.34	1.54	1.58
CI(PTVT)	1.33	1.33	1.23	1.36
HI(PTVN)	0.37	0.42	0.37	0.39
HI(PTVT)	0.11	0.13	0.12	0.13

PTVT and PTVN are respectively the high and low dose treatment volumes defined by the physician. D_V is the absorbed dose that covers a given volume fraction V. HI is the homogeneity index defined by ICRU 83 [9]. CI is the conformation index defined by ICRU 62 and ICRU 83 for $D_{100\%}$ isodose of the evaluated volume in the worst case