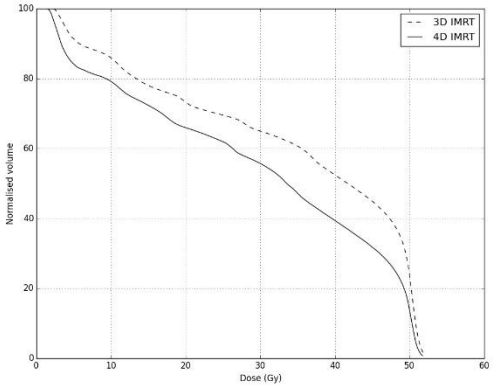
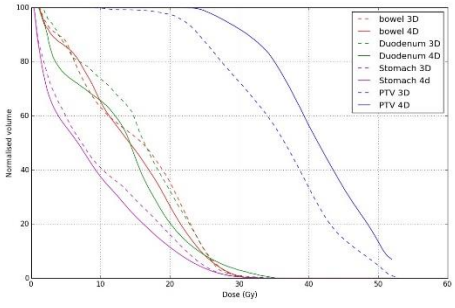
parameters and conventional fractionation (50.4Gy in 28 fractions) as originally used but optimised to the new PTV. In order to investigate the dosimetric difference between 4DCT and 3DCT for pancreas SABR planning patients were outlined according to the SPARC protocol. The PTV was prescribed 35Gy in 5 fractions and the area at risk (PTV_M) was prescribed a dose of 45-50Gy in 5 fractions and the OAR constraints from the SPARC trial were used. PTV coverage was compromised to meet mandatory OAR constraints in both the 3D and 4D plans.

Results

The average PTV volume dropped by 33% and we saw reductions to the mean dose of all OARs in the conventional fractionation. There was no correlation observed between the magnitude of the tumour motion and the reduction in OAR dose. The drop in dose to OAR is highly dependent on tumour position. The most significant OAR improvement was seen in the duodenum with an average mean dose difference of 5.3Gy (range 2.4-6.9Gy), other OAR mean dose reductions are as follows: spine 2.6Gy, bowel 2.9Gy, stomach 4.3Gy, liver 2.2Gy and kidneys 1.4Gy. Figure 1 shows the mean duodenum DVH for conventional 3D and 4D plans.

The dose constraints for the SABR plans were challenging for both 3D and 4D as the majority of patients had OARs overlapping the PTV which had to be carved out. As expected PTV coverage was improved in the 4D plan as there was less overlap with the OARs and OAR doses were generally lower. The mean V95% dropped from 85.5% using the 4D plan to 62.4% using the 3D plan when all mandatory OAR constraints were met. Figure 2 shows the mean DVH for the dose limiting OARs and the PTV receiving 35Gy for SABR 3D and 4D plans. PTV_M coverage was very similar for both plan types. This level of PTV coverage could lead clinicians to dose deescalate, the SPARC protocol also allows 30Gy in 6 fractions and 6.5Gy in 6 fractions.





Conclusion

The use of a 4DCT in pancreas planning results in lower dose to the OARs, improved PTV coverage in the case of SABR planning and the potential for dose escalation.

EP-1881 Sequentially- versus co-optimized plans for pelvis and prostate bed: time efficacy and plan quality

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Purpose or Objective

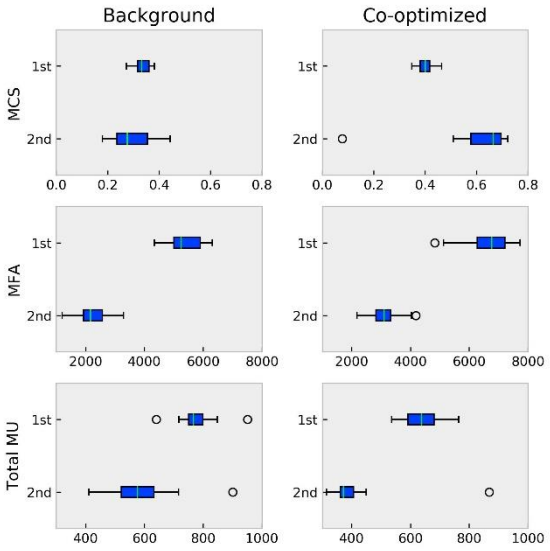
To evaluate the performance of sequentially- and co-optimized treatment planning approaches for pelvic lymph node and prostate bed irradiation in terms of required time, plan quality and modulation complexity.

Material and Methods

Twenty consecutive patients were included in this investigation. For all patients the prescription dose consisted of 50 Gy in 25 fractions for the pelvic lymph node region planning target volume (*1st phase, PTV_LD*), followed by 16 Gy in 8 fractions for the prostate bed (*2nd phase, PTV_HD*). Rectum, bladder and small bowel were delineated as organs at risk (OARs), and used for optimization (by excluding the area overlapping with PTV_LD+2mm). Sequential and combined planning were performed. The sequential approach (background dose based "BG") consisted in a standalone *1st phase* planning, followed by a linked *2nd phase* and total plan optimization, while the combined one (co-optimized "CO") used separate and pooled planning objectives simultaneously for the *1st*,*2nd* and *combined* phases. For all treatment planning Raystation (version 6.1.1.2, Stockholm, Sweden) was used by the same planner with identical initial optimization parameters. Seven field (45 segments) Direct Machine Parameter Optimization (DMPO) class solutions were used for the *1st phase*, while single full rotation modulated ARC (37 segments, sector size of 10° and 4° arclets/sector) for the *2nd phase*, with five field (40 segments) DMPO as backup in case initial arc sequencing failed. Time required to achieve a clinically acceptable plan was measured, followed by a qualitative comparison of relevant dose parameters and assessment of plan Modulation Complexity Score (MCS). Results were compared using paired t-test with $p<0.05$ significance level

Results

Eighty plans were analyzed. The average (range) time (min:sec) required for **BG** based planning was 7:29 (4:20-10:02), 5:27 (3:50-07:36) and **12:56** (8:19-16:17) for 1st phase, 2nd phase and total planning respectively. For **CO** on average 4:24 (-2:42-23:29) more time was required, leading to an average planning time of **17:20** (10:46-39:46)($p=0.01$). For 2nd phase all BG plans consisted of a mARC, while for CO only one plan succeed with proper arc sequencing. On average (±standard deviation) 26.9±9.5%, 40.5±15.8% and 3.3±1.6% of the rectum, bladder and small bowel were overlapped with the PTV_LD+2mm respectively. Statistically significant ($p<0.01$) differences were observed in MCS (Figure): **0.32** (0.18-0.44) vs. **0.51** (0.08-0.72) between **BG** and **CO** respectively without significant differences neither in PTV coverage nor in integral dose (Body V5/20Gy). Furthermore majority of OAR parameters were significantly better using the **BG** approach (Table**).**



ROI	Dose parameter	Plan Phase	Background planning *Mean (SD)*	Co-optimized planning *Mean (SD)*	p-value
Rectum	V50Gy(%)	Total	25.9 (7.9)	33.2 (9.2)	<0.001
	V60Gy(%)	Total	15.8 (5.8)	19.8 (7.5)	<0.001
	V64Gy(%)	Total	10.9 (4.3)	14.0 (6.1)	<0.001
	Dmean (Gy)	Total	35.7 (3.5)	40.9 (4.1)	<0.001
Bladder	V20Gy(%)	Total	77.6 (10.5)	85.2 (10.7)	<0.001
	V35Gy(%)	Total	54.2 (15.1)	59.0 (15.2)	<0.001
	V50Gy(%)	Total	37.2 (14.5)	40.0 (14.3)	<0.001
	V60Gy(%)	Total	27.1 (12.7)	28.8 (12.6)	<0.001
	Dmean (Gy)	Total	40.0 (6.7)	42.5 (6.4)	<0.001
Small bowel	V20Gy(%)	Total	60.2 (13.8)	65.5 (16.8)	0.028
	V35Gy(%)	Total	19.2 (7.0)	24.3 (10.7)	<0.001
	V50Gy(%)	Total	0.7 (0.6)	0.9 (0.7)	0.036
	Dmean (Gy)	Total	23.6 (3.4)	25.3 (4.7)	0.006
Body	V5Gy (cc)	1st Phase	1500 (289)	1696 (330)	0.059
	V5Gy (cc)	2nd Phase	10781 (1838)	10956 (1799)	0.765
	V5Gy (cc)	Total	11494 (1960)	11300 (1800)	0.101
	V20Gy (cc)	Total	5364 (914)	5492 (780)	0.240
PTV_LD	D98%(Gy)	1st Phase	46.9 (0.3)	46.8 (0.5)	0.782
	D2%(Gy)	1st Phase	52.0 (0.1)	52.1 (0.2)	0.116
	V47.5Gy(%)	1st Phase	96.3 (0.8)	96.2 (1.2)	0.741
	V53.5Gy(%)	1st Phase	0.0 (0.1)	0.0 (0.1)	0.381
PTV_HD	D98%(Gy)	2nd Phase	15.2 (0.3)	15.1 (0.2)	0.301
	D2%(Gy)	2nd Phase	16.4 (0.2)	16.6 (0.2)	0.002
	V15.2Gy(%)	2nd Phase	96.2 (5.1)	97.0 (2.1)	0.562
	V17.12Gy(%)	2nd Phase	0.0 (0.1)	0.1 (0.3)	0.449
	D98%(Gy)	Total	64.1 (0.4)	64.7 (0.3)	<0.001
	D2%(Gy)	Total	68.0 (0.3)	67.7 (0.4)	0.003
	V62.7Gy(%)	Total	99.7 (0.4)	100.0 (0.1)	0.004
	V70.62Gy(%)	Total	0.0 (0.0)	0.0 (0.0)	0.330

Conclusion

Sequential plan optimization should be preferred for pelvic lymph node irradiation of 50 Gy followed by 16 Gy boost for the prostate bed, as it resulted in significantly better plan quality in shorter time compared to combined optimization. Modulation Complexity Scores were higher with sequential plans.

EP-1882 Dosimetric comparison between proton SFUD, IMPT and SBRT Boost in clivus chordoma radiotherapy

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Purpose or Objective

Clivus chordoma is a recognized indicaton for protontherapy treatment [1]. Dose escalation is very challenging in this localization due to chiasma, optic nerves and brainstem proximity and their low dose tolerance. The idea of this work is to dosimetrically test different treatment techniques available at Centre Antoine Lacassagne (Nice, France) to reach the therapeutic dose (72-74 Gy RBE), including proton therapy single-field uniform dose (SFUD) and intensity modulated protontherapy (IMPT) both for sequential and integrated boost (SIB) and stereotactic body radiotherapy (SBRT) (Cyberknife®) for sequential boost. The hypothesis was that SBRT could achieve better coverage and conformality than IMPT for the boost.

Material and Methods

10 patients with a clivus chordoma were included in this study. Protontherapy SFUD and IMPT plans were computed with RayStation 6.0 (RaySearch Laboratories, Sweden) and realized with a CTV-based robust optimization with parameters as follow: 3% of the range for range uncertainties and 3 mm for metric uncertainties (patient positionning, contouring, robot couch accuracy…). SBRT treatments were planned with Multiplan (Cyberknife®, Accuray, USA). Plans were calculated for sequential boost with proton SFUD, IMPT and SBRT with 50.4 Gy RBE (1.8Gy RBE/fraction) delivered to the low dose CTV and 23.4 Gy RBE (1.8Gy RBE /fraction) for PT plans or 22 Gy RBE (2Gy RBE /fraction) for SBRT plans to reach 73.8 Gy RBE for PT plans and 72.4 Gy RBE in SBRT. SIB plans were computed to deliver 73.5 Gy RBE (2.1 Gy RBE /fraction) to this volume, the low dose CTV receiving 56 Gy RBE (1.6 Gy RBE /fraction). SBRT was not used for the planning of the low dose CTV because of its to large size.

Results

The dose constraints to the OAR were evaluated following the ICRU91 recommendations for SBRT plans and ICRU78 recommendations for PT plans. All plans were performed to be clinically deliverable and to respect the OAR constraints – the difference between the plans is about the tumor coverage, conformality and homogeneity. In general, plans comparison showed that IMPT SIB achieved better tumor coverage for the boost than SFUD SIB (50.8% vs 70.9% for the example patient shown in Fig.1 and Fig.2); this was also better than sequential SFUD (60.4% vs 70.9%); the best tumor coverage was however reached with SFUD + SBRT technique (80.2% tumor coverage for the example patient). This tendancy was observed for 7 patients over 10. For the other patients the SIB strategy was adopted due to the CTV geometries (large high dose target volume).

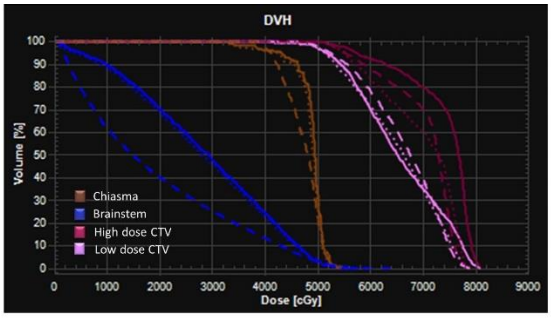

Figure 1. Dose Volume Histogram for sequential SFUD, IMPT SIB and SFUD combined with SBRT plans computed for 2 critical OAR (brainstem, chiasma) and the 2 target volumes for one patient of the cohort.

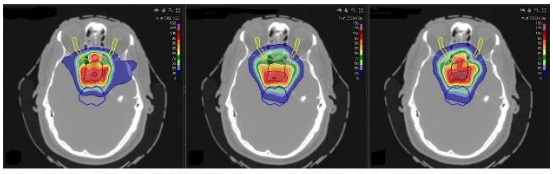

Figure 2. Dose distribution for IMPT SIB (left), sequential SFUD (center) and SFUD combined with SBRT (right) plans computed for one patient of the cohort.

Conclusion

7 over 10 patients were treated with the SBRT technique to reach the therapeutic dose of 73.8 Gy RBE in addition to the SFUD irradiation for the low dose volume, due to