(FLOW12M) and patient-rated xerostomia 12 months (XER12M) after treatment.

Material and Methods

Patients with HNC treated with definitive bilateral radiotherapy (70 Gy in 35 fractions) with or without systemic treatment were eligible for the study. Target volumes and organs at risk (OARs) were delineated according to international guidelines. The parotid gland HSCD regions were contoured using in-house made software. Next, for every patient a standard parotid gland sparing IMRT plan (ST-IMRT) was generated. Second, a HSCD region sparing IMRT (HSCD-IMRT) plan was generated by reducing dose at the HSCD region as much as possible while keeping the whole mean parotid gland dose the same (Figure 1). Finally, patients were randomized between ST-IMRT (arm 1) and HSCD-IMRT (arm 2). Primary and secondary end-points were FLOW12M and XER12M, respectively.

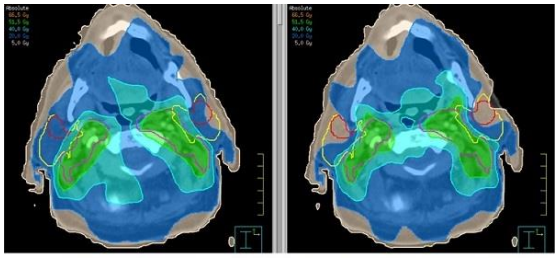

Figure 1. Dose distributions depicted on a CT of a patient with cT3N0 laryngeal cancer using standard IMRT and HSCD region sparing IMRT. The yellow lines are the parotid glands and the red lines are the HSCD regions. With standard IMRT the mean HSCD region dose is 15.8 Gy (right) and 20.6 Gy (left) and with HSCD region sparing IMRT this is 7.4 Gy (right) and 10.8 Gy(left).

Results

The study population was composed of 102 patients. 54 were assigned to receive ST-IMRT (arm 1) and 48 HSCD-IMRT (arm 2). The mean parotid gland dose was similar in both arms (contralateral: 24.2 and 23.8 Gy (p = 0.801) for arm 1 and 2, and ipsilateral: 31.7 and 30.8 Gy (p = 0.659), respectively). HSCD region sparing significantly reduced the dose to the HSCD region (contralateral: 16.4 to 12.6 Gy (p = 0.007) for arm 1 and arm 2, respectively, and ipsilateral: 25.0 to 17.4 Gy (p = 0.005), respectively). Baseline xerostomia and other OARs (oral cavity and submandibular glands) dose were similar in both arms.

Compared to baseline, FLOW12M was reduced with 16.8% and 8.5% (p = 0.621) for arm 1 and arm 2, respectively and XER12M was 50.0% and 45.9% (p = 0.720), respectively.

Multivariate analysis showed that the mean ipsilateral HSCD region dose and baseline xerostomia (none vs. any) were the most important predictors for XER12M. Subset analysis on patients without baseline xerostomia (n = 57) showed that the rate of XER12M was markedly lower, i.e. 40.0% v. 23.8% (p = 0.253) in arm 1 and arm 2, respectively. Furthermore, in this subgroup the only significant different dose parameter between patients with or without XER12M was ipsilateral HSCD region dose (28.9 v. 19.1 Gy, p = 0.007).

Conclusion

In this double-blind RCT, stem cell sparing IMRT did not significantly improve salivary flow or reduce xerostomia 12 months after radiotherapy. However, the ipsilateral HSCD region dose was the most important dosimetric predictor for xerostomia, suggesting that dose to the HSCD region is more important for the development of xerostomia than dose to the entire parotid gland.

Award Lecture: Highlights of proffered papers

OC-0632 Radiotherapy-related lymphopenia affects overall survival in patients with lung cancer

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Purpose or Objective

Lymphopenia during radiotherapy (RT) has an adverse effect on patient's quality of life and can be life threatening. However, the relationship between RT dose and lymphopenia is still unknown. This work utilized data mining to identify anatomical regions where the received dose is correlated with lymphopenia. A predictive model of lymphopenia is also proposed.

Material and Methods

562 lung cancer patients treated with curative intent RT were used as a development set. All patients had baseline lymphocytes ≥ $0.5x10^9$/L. A Cox model was used to assess prognostic factors of overall survival. Next, two matched groups were defined - patients with and without lymphopenia ≥ G3 (lymphocytes at nadir < $0.5x10^9$/L according to CTCAE v4.0) - based on planning target volume (PTV), baseline lymphocytes, prescribed dose, and histology. The purpose of matching was to eliminate tumor effects and improve data mining sensitivity. Following matching, 386 patients remained and image-based data mining was used to identify regions where dose correlates significantly with lymphopenia ≥ G3. For that purpose, dose matrices (equivalent dose at 2 Gy/fraction, α/ß=10) were aligned using registration of the planning CT images to one reference patient. Then, mean dose distributions were obtained for the two groups and organs of significance were detected. For these organs, various dose parameters were collected and those having the highest correlation with lymphocytes at nadir were selected for analysis. Multivariate analyses were conducted for the full development set by employing the identified dose parameters, along with non-dosimetric parameters significant in univariate analysis ($p < 0.05$). Finally, the model was validated on 301 esophageal cancer patients.

Results

Cox regression showed that lymphopenia ≥ G3 in addition to age, PTV, performance status, and RT duration was an independent factor predicting overall survival in lung cancer (Figure 1). The heart, lung, and thoracic vertebrae showed regions where the difference in dose between the matched groups, with and without lymphopenia ≥ G3, was significant. Mean dose to the heart and lung, and V_{20} of the thoracic vertebrae (volume receiving >20 Gy) correlated most with lymphocyte counts at nadir in the matched set. A model including RT duration, baseline lymphocytes, vertebrae V_{20}, and mean heart dose was then chosen following backward elimination (Table 1). The Hosmer-Lemeshow test, based on deciles of risk, indicated that the model was a good fit. Accuracy and C-statistics of the model in the development set was 75% and 0.82 and in the validation set was 75% and 0.76, respectively.

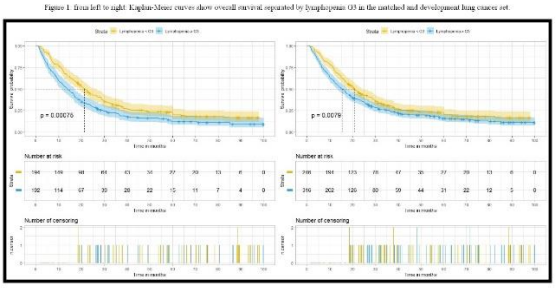

Table 1: Logistic regression results for patients/cancer characteristics and selected dosimetric parameters associated with lymphopenia ≥ G3

Lymphopenia ≥ G3		Univariate Logistic Regression		Multivariate Logistic Regression	
	n (%/median (range))	OR	P value	OR	P value
Patients parameters	562				
Gender					
Female	257 (46%)	ref			
Male	305 (54%)	1.04	0.800		
Age (yr)	64 (22-93)	1.00	0.800		
Baseline lymphocytes ($x10^9$/L)	1.7 (0.5-12.4)	0.70	**<0.001**	0.40	**<0.001**
log(PTV)	2.6 (1.4-3.2)	7.90	**<0.001**		
PS					
0	135 (24%)	ref			
1	316 (56%)	1.00	0.900		
2	83 (15%)	0.60	0.070		
3	19 (3%)	0.80	0.600		
Histology					
LUAD	127 (22%)	ref			
LUSQ	168 (30%)	1.20	0.400		
SCLC	189 (34%)	0.50	**0.003**		
NoS	78 (14%)	1.10	0.600		
N Stage					
0	122 (22%)	ref			
1	51 (9%)	1.10	1.000		
2	275 (49%)	1.80	**0.005**		
3	75 (13%)	1.40	0.200		
Therapeutic parameters					
Chemotherapy status					
RT only	88 (16%)	ref			
pre Sequential RT	148 (26%)	0.80	0.400		
Concurrent	326 (58%)	1.50	0.100		
RT dose parameters					
RT duration (days)	28 (17- 57)	1.11	**<0.001**	1.13	**<0.001**
Lung mean (EQD2 Gy)	14.7 (2.4-29.1)	1.15	**<0.001**		
Heart mean (EQD2 Gy)	10.2 (1.1-32.7)	1.06	**<0.001**	1.04	**0.010**
Thoracic Vertebrae $V_{20\ (EQD2)}$	31.7 (0.02-81.3)	1.03	**<0.001**	1.02	**0.030**

OR: odds ratio; PTV: planning target volume; LUAD: lung adenocarcinoma; LUSQ: lung squamus carcinoma; SCLC: small cell lung cancer; NoS: not otherwise specified; RT: radiotherapy; EQD2: equivalent dose at 2 Gy/fraction (α/β=10)

Conclusion

Lymphopenia ≥ G3 during RT is a significant risk factor for survival in lung cancer patients and careful management is thus required e.g. by minimizing vertebrae V_{20} and mean heart dose in order to limit irradiation of stem cells and blood pool. If dose constraints cannot be met, more frequent monitoring of lymphocyte counts during therapy and use of prophylactic antibiotics are recommended.

OC-0633 Single dose high dose-rate (HDR) brachytherapy as monotherapy for localised prostate cancer

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Purpose or Objective

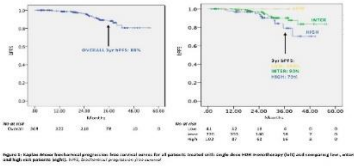
Several series have confirmed the safety and efficacy of multi-fraction high-dose rate (HDR) brachytherapy (BT) as monotherapy for localised prostate cancer. The role of a more cost-effective and convenient single fraction regime is developing with some conflicting efficacy results to date. We report early tumour control and toxicity outcomes from a national UK database of patients treated in a unifying protocol with a single 19Gy dose of HDR brachytherapy as monotherapy for localised disease.

Material and Methods

From 2013 to 2018, 369 patients with D'Amico classified low (n = 41), intermediate (n = 226) and high-risk (n = 102) prostate cancer were treated in a UK national protocol with HDR monotherapy to a dose of 19Gy delivered in a single treatment exposure; corresponding biologic equivalent prostate dose to 2Gy per fraction of 111Gy (α/β = 1.5). Brachytherapy planning objectives were rectum D2cc <15Gy and maximum <19Gy, urethra D10 <22Gy, D30 <20.8Gy and maximum <28.5Gy. Androgen deprivation therapy (ADT) was given to 36.9% of patients with duration ranging from 6-36 months. Biochemical failure was defined as prostate-specific antigen (PSA) rise of ≥2ng/ml above nadir post-BT. Acute and late genitourinary (GU) and gastrointestinal (GI) toxicities were evaluated using the Common Terminology Criteria for Adverse Events, version 4.0 guidelines. Late toxicity was defined as that originating ≥90 days after implant.

Results

Median follow-up was 26 months. The 2-year biochemical progression-free survival (bPFS) rate was 96% for all patients and 100%, 97% and 95% for low-, intermediate- and high-risk patients respectively. 3-year bPFS rates were 88% (overall), 100% (low-risk), 90% (intermediate-risk) and 79% (high-risk) (p=0.1) (Figure 1). Sites of relapse were radiologically identified in 21 of the 27 biochemical failures (Table 1). Of these, 14 had a local prostate recurrence. Acute grade 2 GU and GI toxicity peaked at 1 month post-implant; prevalence rates of 12% and 3% respectively. No grade 3 or 4 acute toxicity was reported. Two patients developed late grade 3 GU toxicity, both surgically-managed urethral strictures. Two patients developed late grade 3 GI toxicity, both rectal fistulae requiring colostomy.



Recurrences	n
Biochemical – imaging negative[1]	2
Biochemical – no imaging	4
Local relapse (prostate only)	11
Loco-regional (prostate + pelvic nodes)	1
Local + distant	2
Isolated pelvic nodal relapse	1
Regional + distant	3
Distant alone	3
Total	27

[1]Imaging comprised pelvic MR or Abdominopelvic CT and bone scan

Table 1: Sites of relapse for patients with biochemical failure

Conclusion

HDR monotherapy delivered in a single dose of 19Gy is a safe and effective treatment for localised prostate cancer that is well-tolerated over the first two years with very good early biochemical control. Further data on long-term efficacy and late toxicity are required. Where biochemical failure occurred in intermediate and high-risk patients, isolated local relapse predominated supporting the rationale for further focal dose escalation to the dominant nodule which should be feasible given the low toxicity of the regime.

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OC-0634 Implementation of plan of the day adaptive radiotherapy: Compliance to guidelines

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