Results: The study population consisted of 206 patients treated with surgery and 136 patients treated with RT. Median follow up was 6.6 years. Patients in the surgical cohort were younger, with mean age: 48.9 versus 60.7 years, $p < 0.001$, and had larger tumours, with mean maximum dimension: 25.7 vs 10.3 mm versus 20.3 vs 6.6 mm, $p < 0.001$. After all VS treatments, the population's PFS was 92.8% at 1 year, 90.5% at 5 years, and 83.7% at 10 years. The population's SH preservation at last follow up was 34.2%. SAEs occurred in 4.7% of patients. In the radiotherapy cohort of 136 patients, 17% had previous surgery (four complete resection, five planned subtotal resection and 14 unplanned partial resection). Sixty-seven percent had single-fraction stereotactic radiosurgery and 33% had fractionated stereotactic radiotherapy. Seven percent had progressive disease requiring salvage surgery. Eighteen percent had FND (HB Grade 2 or more) at presentation. No patients had improvement in FND after RT and 17% had new or worsened FND after treatment. SAEs were: hydrocephalus requiring ventriculoperitoneal shunt 1.5%, radionecrosis 0.7%, hospitalization for steroid myopathy 0.7%, and death from complications of disease 0.7%. In the surgical cohort of 206 patients, 8% had previous treatment (eight radiation, nine surgery). The most common surgical approaches were: radiosurgery (89%) and transsphenoidal (6%). Two percent had planned post-op RT and 12% had disease progression requiring salvage: 19 RT, three surgery, two unknown. Twelve percent had FND at presentation. FND improved in 4.4% and worsened in 12.6% after surgery. SAEs were: increased intracranial pressure requiring external ventricular drain 2.9%, dural fistula requiring lumbar drain 1.5%, evacuation of hematoma 1.0%, and perioperative death 0.5%.

Conclusions: Multidisciplinary management of VS provides excellent disease control at a population level with hearing preservation in a minority of patients and a low-risk of serious adverse events.

213 SERIAL MAGNETIC RESONANCE SPECTROSCOPY IMAGING PREDICTS CLINICAL OUTCOMES IN HIGH-GRADE GLIOMA DURING AND AFTER POST-OPERATIVE RADIOTHERAPY
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Purpose: Conventional imaging methods, such as computed tomography (CT) and magnetic resonance imaging (MRI) are not as effective as magnetic resonance spectroscopy (MRS) in diagnosing, grading, and evaluating high-grade glioma (HGG) tumour response to treatment. MRS uniquely determines whether tumour is viable or contains metabolic activity following post-operative radiotherapy (RT). This study’s preliminary data was published, and has currently become the largest prospective trial to investigate the correlation between changes in MRS spectra in HGG patients before, during, and after post-operative RT with overall survival (OS).

Methods and Materials: Forty-four patients with histologically confirmed HGG prospectively completed surgery and RT to 6000 cGy. MRS was performed prior to starting RT, during week 4 of RT, and at two months post-RT. Metabolite ratios of: 1) choline / creatine; 2) NAA/creatine; and 3) choline/NAA were calculated from MRS spectra at each time point. Normalized metabolite ratios, defined as Tumour metabolite/Normal contralateral brain metabolite, were evaluated for differences in OS from baseline to post-RT. Kaplan-Meier curves of OS were analyzed for statistical significance by the log-rank method, and paired groups of metabolite ratios examining changes over time were compared using the paired t-test, with a significance value of $\alpha = 0.05$.

Results: After a median follow up of 21.0 months, mean normalized choline significantly decreased from baseline to two months post-RT (1.98 versus 1.35, $p = 0.019$). Patients with < 60% decrease in normalized choline from baseline to two months post-RT had a significantly better median OS (34.98 versus 10.49 months, $p = 0.049$). Moreover, patients with any increase in normalized choline from baseline to week 4 of RT had significantly better median OS after completing RT (39.19 versus 16.09 months, $p = 0.037$).

Conclusions: This study is the largest prospective trial to demonstrate that changes in normalized choline from baseline to two months post-RT are highly predictive for OS. These prognostic MRS changes further strengthen the clinical use of advanced imaging techniques to improve the diagnostic and grading effectiveness of imaging, to noninvasively sample the molecular features of gliomas, to evaluate local tumour response to radiotherapy, and to optimize individualized treatments for patients with HGG.

214 RECTAL DVH: IS V40 GY < 55% A RELEVANT, ACHIEVABLE SURROGATE FOR RECTAL TOXICITY, AND CAN IT BE SAFELY OMITTED?
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Purpose: Rectal toxicity can be a significant consequence of prostate radiation therapy, and a number of different dosimetric parameters have been used with the intention of decreasing rectal toxicity. This has led to a wide array of retrospective trials wherein different definitions of the rectum led to variation in DVH (dose volume histogram) data. Compounding this, many dose escalation studies have been done in the last decade after a close relationship between local control and radiation dose was found. This resulted in a variety of DVH recommendations without clear consensus in the literature.

Methods and Materials: As part of a quality assurance task, random data on 50 consecutive prostate cancer patients treated at our institution with rapid arc protocol was analyzed. Defined constraints were studied and evaluated: if they fulfilled organ at risk (OAR) limitations as per institutional protocol, or if some OAR constraints were too stringent. This included rectal V40 Gy < 55%, which has not been quoted in recent RTOG trials.

Results: Rectal data analysis highlighted that V75 Gy < 15%, V70 Gy < 20% and V60 Gy < 35% were achieved in all patients. V65 Gy < 25% and V50 Gy < 50% were achieved in 98% of the patients. Bladder constraints including V80 Gy < 15%, V75 Gy < 25% and V70 Gy < 35% were achieved in all patients. However, V65 Gy < 50% and V40 Gy < 70% were achieved in 96% of the patients. Mean dose of < 50Gy for Penile bulb was achieved in only 74% of patients. Femoral head tolerance (V53 Gy < 5%) was achieved in all patients. Bowel DVH of V45 Gy < 15 cc was met for most of the patients. However, contouring differed between radiation oncologists for the bowel.

Conclusions: Rectal dose constraints to decrease the probability of rectal toxicity have been based on a number of studies. Although these constraints are not achievable in a significant number of patients, stringent parameters have been put forward with the intention of decreasing rectal toxicity. Confounding variables may interpretation of data with these stringent parameters difficult. Recent RTOG studies have not included stringent parameters of V40 Gy < 55%. More studies need to be done to determine if such stringent parameter can be omitted altogether.

215 ATTEMPTED VALIDATION OF A CBCT DERIVED RADIOSENSITIVITY MARKER TO PREDICT RADIATION PNEUMONITIS
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Purpose: Dose escalation of non-small cell lung cancer is typically limited by increasing risk of severe adverse events, including radiation pneumonitis (RP). Recent studies have demonstrated a relationship between a CBCT derived marker (CDM) and lung density changes on follow up imaging. This study investigates the relationship between a density-based CBCT image marker and symptomatic radiation pneumonitis.

Methods and Materials: CDMs were extracted for NSCLC patients treated definitively (> 54 Gy) with fractionated radiotherapy between 2011 and 2013. The CDM was defined as the proportion of normal lung voxels receiving 20-60 Gy that demonstrated an intensity increase between the first and tenth fraction CBCT, as previously described. Only voxels with an intensity change greater than a defined noise threshold were included. All images were repositioned in a common volume using an intensity-based deformable image registration algorithm in the Elastix toolbox. All other image analysis was implemented in Matlab 2010b. RP was determined from prospective clinical records and reviewed retrospectively from the electronic patient record, as scored by the treating oncologists at follow up visits as per CTCAE v 4.0. Dosimetric parameters extracted included mean lung dose and volume of lung receiving 20 Gy (V20). Correlation of dosimetric parameters and the CDM to RP events was assessed by Spearman’s rank correlation coefficient and multivariate logistical regression.

Results: After excluding patients without dose or CBCT objects, 65 patients were identified and CDM extracted. In those patients, the prescription dose range was 54-74 Gy, mean lung dose range was 13-23 Gy and V20 range was 3.4 - 38%. The number of voxels with an intensity change greater than the noise level ranged from 0-74.5% (mean 5.3%). Symptomatic RP (≥ Grade 2) occurred in 21.7% of patients of these patients. Spearman’s rank correlation demonstrated significant association between mean lung dose and V20 with symptomatic radiation pneumonitis (p = 0.044 and p = 0.036 respectively), whereas the CBCT marker was not correlated (p = 0.609). Univariate logistic regression of mean lung dose and the CBCT marker was not significantly correlated (p = 0.036 respectively), whereas the CBCT marker was not correlated (p = 0.609). Univariate logistic regression of mean lung dose and the CBCT marker was not significantly correlated (p = 0.077).

Conclusions: One previously described density-related CDM was not correlated with RP in this dataset. Further research is required to characterize the role of imaging markers in predicting radiation pneumonitis.

216 SURFACE DOSIMETRY OF PATIENTS UNDERGOING TOTAL BODY IRRADIATION (TBI): A RETROSPECTIVE ANALYSIS FOR QUALITY ASSURANCE

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Purpose: Total body irradiation (TBI) is used prior to bone marrow transplantation as part of the conditioning regimen in selected patients. A linear accelerator based technique has been used at our treatment centre, between 2004 and 2015. Compensators to account for missing tissue in the head and neck and lower leg regions, as well as a lung attenuator for internal inhomogeneity resulting from low density lung tissue are routinely used. Dose variation within ten percent of the prescribed midplane dose is considered acceptable. The purpose of this study was to determine whether dose variation was within acceptable limits for patients who underwent TBI.

Methods and Materials: Following chart review, 129 patients between June 2004 and August 2015 who received TBI in six fractions were included in this study. Patients receiving single fraction treatment were excluded. MOSFET dosimetry was used to measure surface dose at 4 or 5 locations when patients received the first fraction of TBI. Dosimetry was repeated during the second fraction for any site with variation greater than ten percent, or when MOSFET position was noted to have shifted.

217 LEADERSHIP EDUCATION IN RADIATION ONCOLOGY RESIDENCY TRAINING

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Purpose: The CanMEDS framework defines the core physician roles on which specialist medical education in Canada is based. The revised CanMEDS 2015 framework introduces “Leader” as a new CanMEDS competency. In this study, we identified leadership training gaps in radiation oncology residency and developed a focused curriculum specific to radiation oncology to meet this new competency requirement.

Methods and Materials: A questionnaire was administered to senior residents and recent graduates of a radiation oncology residency training program in Canada. Qualitative data regarding staff and resident leadership responsibilities, leadership training in residency, and any perceived gaps in residency leadership training were gathered. Based on identified educational needs, a leadership curriculum was developed and administered to current radiation oncology residents.

Results: Following analysis of the qualitative questionnaire data, three modules were designed to address the identified gaps in radiation oncology residency leadership training. Specifically, the modules were developed to increase knowledge and execution of different leadership styles, develop skills in teamwork and negotiation, and recognize specific leadership qualities within each resident.

Conclusions: In this study, we identified important leadership competencies for radiation oncology residents as they transition into fellowship and junior consultant positions. To our knowledge, this is the first description of a radiation oncology-specific leadership curriculum designed to meet these needs.

218 USING 3D PRINTER TECHNOLOGY TO MANUFACTURE ANATOMIC MODELS FOR PATIENT EDUCATION: A NEW FRONTIER

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Purpose: The use of 3D printing technology to create precise anatomical models is well documented. These models are used by surgeons to better plan upcoming operations and to save valuable operating room time. They are also used to educate other members of the health care team, such as residents, medical students and nurses. However, the use of these anatomically accurate models to educate patients in the clinical setting has been underutilized. At our centre, we are using 3D printer technology to generate accurate clinical models of mandibles. Our objective is to use these models to better