SP02.6 Assessing the diagnostic sensitivity of CT and Ultrasound in suspected appendicitis

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Background: Acute appendicitis is one of the most common emergency presentations in surgery(1) . CT Scan is considered a highly sensitive and specific tool in the assessment of acute appendicitis(2). Ultrasonography is still considered as a first-line imaging modality in children/young adults and women of child-bearing age because of concerns regarding high radiation exposure associated with CT. Nevertheless, it is operator-dependent and can be affected by anatomy variation and the patient's body habitus(3).
Method: 1 Retrospective analysis of 9 months' data of all patients who underwent appendicectomies. 2 Review pre-appendicectomy radiology reports and post-appendicectomy histopathology reports. Target: For CT: The sensitivity value should be >90%(4). For US: The overall sensitivity value (includes adults and paediatric subgroup) should be >70% on interval scan following an initial US screening test. The sensitivity value in the paediatric subgroup should be >85%(4). The CT positive predictive value should be >92%(5). The negative appendicectomy rate should be <10% for CT(6).
Results: Out of a total of 304 patients who underwent appendicectomies, 88 patients had pre-appendicectomy CT, and 56 patients had pre-appendicectomy Ultrasound. The CT sensitivity was 95%. The overall Ultrasound sensitivity was 24%, and the sensitivity in the paediatric subgroup was 40%. The CT positive predictive value was 92%. The CT negative appendicectomy rate was 0%.
Conclusion: All the targets of the CT scan were met. Although no interval Ultrasound scans are performed in the hospital, the results highlighted the poor performance of Ultrasound, compared to CT, in the assessment of appendicitis.

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Proffered papers: Clinical oncology – therapy

SP03.1 Evidence of OAR dose reduction for anal and rectal cancer MR-only planning treatments

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Background: For anal and rectal cancers there is no direct evidence showing the benefit of MR-only planning to patient treatments. This study aims to assess the impact of MR-only planning on target volumes and treatment plan doses to organs at risk (OARs) for anal and rectal cancer patients vs. a routine CT-simulation pathway.
Methods: 46 patients (29 rectum and 17 anus) undergoing radical VMAT EBRT received CT and T2-SPACE MR simulation. For CT and MR, RT target volumes (TV) and organs were delineated and RT VMAT treatment plans were optimised following our routine clinical protocols independently. The impact of dose boosting was also assessed. Differences in TV volumes and OAR doses (Vx Gy (volume receiving x dose)) were assessed.
Results: MR GTV and primary PTV volumes reduced vs. CT by 13 cc and 98 cc (anus) and 44 cc and 109 cc (rectum) respectively. The following OARs had statistically significant dose reductions vs. CT; for rectum; bladder and uterus, and for anus; bladder, penile bulb, and genitalia. With GTV boosting, statistically significant dose reductions were also found for additional OARs including; sigmoid, small bowel, vagina, and penile bulb (rectum) and vagina (anus). Further OARs had dose reductions close to statistical significance for standard and boost plans.
Conclusion: Our findings provide evidence that MR-only planning for anal and rectal cancers results in statistically significant reductions in TV volumes and reduced doses to OARS. OAR dose reductions may translate into less treatment related toxicity for patients.

SP03.2 Evaluating the dosimetric impact of uncorrected and IAEA corrected small field output factors on SABR plans with Monte Carlo and Acuros algorithms

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Background: Recent publications by Sendani(2019) and Mamesa(2020) have investigated the impact of IAEA corrected output factors (OF) on beam modelling. This study builds on this work by comparing a Monte Carlo and Acuros algorithm focusing on SABR planning.

Methods: Corrected small field OF were determined using a microdiamond (0.004mm^3) chamber using the intermediate field size method. A 6FFF True Beam HDMLC beam model was produced by Elekta using the IAEA OF for use in Monaco. Output factors, PDDs, off-axis ratios, fluence maps, VMAT plans and 10 patient SABR plans were prepared and calculated in Eclipse (uncorrected OF) using AXB (V13.6.23) and recalculated and compared in Monaco (V5.10.02).

Results: For static fields, differences in OF were <1% for jaw-defined and <2% for MLC-defined field sizes down to 2x2cm^2. Conformal, half-arc and VMAT prostate plans had dose differences <2% at isocentre and <1% difference in mean dose to PTV. VMAT SABR plans had a systematic dose discrepancy of -5.0% at isocentre in Monaco (SD: 1.5%, range 2.8%-7.8%) and a similar systematic decrease in mean dose to PTV (-4.9%, SD: 1.4%, range 2.3%-7.0%). Percentage differences in mean doses to OARs varied between -22.9% to 11.9%.

Conclusions: For static fields and simple plans there was minimal impact from using corrected OF. However, a significant difference has been found between the two planning algorithms for PTV and OAR doses in VMAT SABR plans. Further work will include comparing patient plan calculated to measured doses and looking into differences in MLC modelling for very small fields.

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SP03.3 Margin reduction strategy in rectal cancer short course radiotherapy

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Background: Short course radiotherapy for rectal cancer (SCRTrc) delivers large doses. Planning target volume (PTV) margins include set-up error to encompass clinical target volumes (CTV).

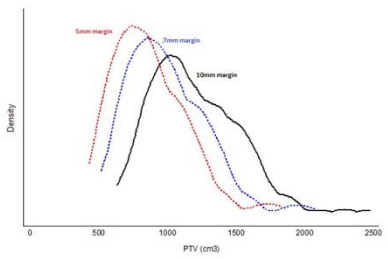
Aim: To assess safety of reducing PTV margin in SCRTrc. 1.Calculate set-up error margin if using an offline imaging protocol. 2.Describe effect of reduced margins on volume? 3.Do reduced PTV margins of 7 or 5mm maintain daily CTV coverage?

Methods: Patients were treated with VMAT 25Gy/5 fractions. Daily CBCT images were registered to bone with all shifts applied. Radiographers assessed PTV10mm target coverage and OAR before treatment. The group systematic error(Σ) and random error(σ) was calculated for the AP, SUP/INF and R/L shifts. Setup error margin was calculated for offline protocol using Van Herk et al. equation(2.5Σ+0.7σ). PTV7mm and PTV5mm were created retrospectively and volumes recorded. Two radiographers assessed daily coverage of all PTV margins.

Table 1. Absolute volumes for each structure.

PTV vol (cm^3)	PTV10mm	PTV7mm	PTV5mm
min	636.52	521.43	432.85
max	2476.43	2077.53	1836.59
median	1147.41	934.12	807.035
IQR	986.55-1451.01	807.99-1204.70	700.02-1058.81

Figure1. The distribution of PTV volumes for 5,7 and 10mm margin.



Results: Forty patients (CBCTn=200) were analysed, median age 70(IQR60.75-77) rectum level upper(n=10), mid(n=8) and lower(n=22). Using an offline protocol, set-up error margin was calculated as 9.1, 8 and 9.5 mm on the AP, SI and RL respectively. PTV volumes are shown in table1 and distribution in figure1.For PTV7mm and PTV5mm CTV coverage failed in 2.5%(5/200)and 4.5%(9/200) of fractions respectively. Occurring for 7.5%(n=3) and 15%(n=6)of patients. Occurring with PTV7mm 2/5 fractions(n=2), and 1/5(n=1); with PTV5mm in 2/5 fractions(n=3), and 1/5(n=3).

Conclusion: Daily CBCT allows safe margin reduction, essential to mitigate set-up error. Although PTV5mm covers most patients, PTV7mm provides a cautious approach. Enhanced bladder/rectal preparation could improve CTV coverage.

SP03.4 Survey of UK adaptive radiotherapy practices for head and neck cancer patients

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Objective: To provide evidence on the extent and manner in which adaptive practices have been employed in the UK and identify the main barriers for the clinical implementation of adaptive radiotherapy (ART) in head and neck (HN) cancer cases.

Methods: In December 2019, an online questionnaire, of 23 questions, was sent to all UK radiotherapy centres (67). This covered general information to current ART practices and perceived barriers to implementation.

Results: 31 centres responded (46%). 56% responding centres employed ART for between 10 to 20 patients per annum. 96% of respondents were using cone beam computed tomography (CBCT) either alone or with other modalities for assessing "weight loss" and "shell gap," which were the main reasons for ART. Adaptation usually occurs at week 3 or 4 during the radiotherapy treatment. 25 responding centres used an online image-guided radiotherapy (IGRT) approach and 20 used an offline ad-hoc ART approach, either with or without protocol level. Nearly 70% of respondents required 2 to 3 days to create an adaptive plan and 95% used 3-5mm adaptive planning target volume (PTV) margins. All centres performed pre-treatment QA. "Limited staff resources" and "lack of clinical relevance" were identified as the two main barriers for ART implementation.

Conclusion: There is no consensus in adaptive practice for HN cancer patients across the UK. For those centres not employing ART, similar clinical implementation barriers were identified. This survey is also an insight into contemporary UK practices of adaptive radiotherapy for HN cancer patients indicating national guidance for ART.

SP03.5 Investigation of latencies for a visual biofeedback system on the Unity MR-linac

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Background: MR-Linac systems enable use of MRI for real-time tumour motion estimation. At the local centre an MR-compatible in-room monitor provides visual biofeedback, allowing for real-time patient-assisted breathing modulation for improved respiratory gating. For this, latency should be minimised. In this work, image streaming via MR-TC (external MRI control-interface) is compared with cloning part of the MRI console. Additionally, biofeedback's impact on gating efficiency is investigated.

Method: Experiments were performed on a Unity MR-linac (Elekta AB, Stockholm, Sweden). A motion phantom (T=4s, A=10mm) provided low-latency (<1ms) reference position data. Sagittal T1GRE sequences were acquired at 4/8/12Hz. In-house software was used to time-stamp and clone the AutoView section of the Philips MRI console. Template-matching identified the phantom's position. By fitting sinusoidal models, the phase difference between phantom-reported and screen-cloning-observed positions was used to determine the latency[1]. Alternatively, cine-MR images were streamed via MR-TC and similarly processed to determine MR-TC latency. Gating efficiency was assessed for 3 healthy volunteers, with and without biofeedback. A rolling graph of current positions, based on extracted breathing traces from the MR-TC images, and gating window was shown on the in-room MR-compatible screen.

Results: MR-TC latency was 49-91ms. For screen-cloning, this latency was increased by 80-91ms for the same MR-sequences. Jitter was below 20ms for all sequences. Gating efficiency was increased by 24-58 percentage points with biofeedback (see Figure 1).

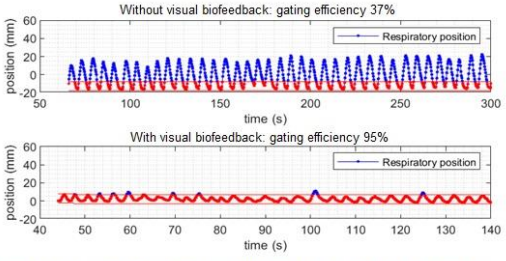

Figure 1: An example of gating efficiency on the Unity MR-linac with and without visual biofeedback.

Conclusion: Screen-cloning was found to be easily implemented, while MR-TC is recommended due to lower latencies and reduced jitter. Gating efficiency was dramatically improved by visual biofeedback.

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SP03.6 Introducing and managing the spleen as a standard organ at risk in the radical treatment of upper gastro-intestinal cancers in South West Wales Cancer Centre (SWWCC)

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Background: The spleen has not been considered a standard organ at risk (OAR) during radiotherapy treatment for upper gastro-intestinal cancer. However, there is growing evidence of the risk of radiotherapy induced hyposplenism following splenic irradiation with a mean dose > 10Gy, and particularly > 40Gy (1,2) This may result in increased risk of infection and OPSI (overwhelming post-splenectomy sepsis). (3)

Method: Within SWWCC, patients who received > 45Gy radiotherapy for upper gastro-oesophageal cancers between January 2016 and August 2020 were analysed to assess splenic mean dose. Pancreatic cancers were included from January to August 2020.
Results: Of the 117 patients identified, 65 had received a mean dose to the spleen > 10Gy (55%). Only 1 of the 12 pancreatic cases identified were found to have a mean dose > 10Gy (8.3%). No patients received a mean dose > 40Gy. Work is ongoing to contact all patients identified, and initiate appropriate prophylactic lifelong antibiotics and vaccinations as per post-splenectomy local trust guidelines (4) (excluding patients with life expectancy < 3 months). Prospectively, hyposplenism is now included as a potential risk in standard consent. A radiotherapy induced hyposplenism pathway is under development to ensure all patients at risk are identified, counselled and treated as above in collaboration with our physics department, radiotherapy review treatment radiographers, clinical nurse specialists and general practitioner colleagues.
Conclusion: This project has identified the importance of identifying this cohort of patients as a high proportion of these patients are at potential risks of the complications of hyposplenism.

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Proffered papers: Breast

SP04.1 Audit of Recall Rate in High Risk MRI breast screening

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Introduction: BRCA gene mutation carriers and women who have had previous thoracic radiotherapy are classified as very high risk of developing breast cancer and are entitled to annual screening with MRI +/- mammogram over age 30. Further assessment is recommended for MRI detected indeterminate or suspicious masses ≥5mm, or non-mass enhancement ≥10mm. The minimum standard for recall rate is <10% with an expected standard of <7%. Nationally this has been difficult to achieve so this audit aimed to review recall rates and outcomes in a single breast screening unit.
Method: All high-risk screening MRIs conducted between January 2014 and September 2019 were reviewed including classification, type of follow up imaging and any biopsy results.
Results: There were 283 screening episodes between January 2014 and September 2019. Nineteen patients were recalled for assessment (12 prevalent screens, 7 incident screens), for an overall recall rate of 6.7%. The recall rate per year varied from 3% to 9% with no discernible trend. Five cancers were diagnosed (cancer detection rate 17.6/1,000; PPV for recall 26%). On retrospective review of recalls, 3 were deemed unnecessary. All 3 were before a protocol change to include subtraction images; in one case there was misinterpretation of diffusion weighted imaging.
Conclusion: In a centre with a small number of experienced MRI reporters and a rigorous protocol, it is possible to meet the expected recall rate standard. Diffusion weighted imaging is invaluable for increased specificity, especially in prevalent screens.

SP04.3 A service evaluation of a newly introduced KV-MV pair imaging protocol for five fraction breast treatments.

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NHS Tayside

Background: Publication of the FAST FORWARD trial and the impending consequences of the Covid epidemic resulted in the need to implement an alternative breast pathway locally. The dose and fractionation regime to be adopted was 26Gy in 5#. Due to the higher fractional dose it was felt that existing imaging verification methods, in beam MV imaging only, would be insufficient to ensure set-up accuracy.
Method: A new daily treatment KV-MV pair imaging strategy was devised and implemented to support the new dose and fractionation regime. The first 30 patients referred were evaluated on the basis of displacements and lung depth. The following local imaging tolerances were applied to each daily image: 10mm for displacements on initial online