

Scientific Paper Abstracts Presented at the Society of Abdominal Radiology 2019 Annual Scientific Meeting and Educational Course (March 17–22, 2019, Orlando, Florida)

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The following are abstracts presented at the Society of Abdominal Radiology 2019 Annual Scientific Meeting and Educational Course. The abstracts are separated into Hot Topics in Gastrointestinal Radiology, Hot Topics in Genitourinary Radiology, At the Cutting Edge, Improving Clinical Practice and Power Science categories. The authors of these presentations gave permission to print their abstracts in *Abdominal Radiology*.

HOT TOPICS IN GI SCIENTIFIC PAPER SESSION

7:16 AM

METABOLIC BIOMARKERS USING CT IMAGING AND TUMOR GENE EXPRESSION PREDICT SEX-SPECIFIC SURVIVAL IN PATIENTS WITH PANCREATIC ADENOCARCINOMA

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Purpose: We identified that sex differences in tumor and host metabolism can stratify patients with renal cell carcinoma (PMID 29558292). We sought to identify metabolic biomarkers using CT imaging (fat and muscle quantification) and gene expression profiles of tumors to predict overall survival (OS) in patients with pancreatic adenocarcinoma in a sex-specific manner.

Materials and Methods: In this IRB-approved retrospective study, we analyzed pre-operative CT exams in 98 male and 107 female patients with pancreatic head adenocarcinoma. Normalized visceral

fat (rVFA) and total abdominal muscle area (nTAMA) were performed according to published methods. Kaplan–Meier and log-rank tests were used to estimate OS. Cox regression models were developed to identify interactions between sex, metabolism, and survival. Optimal thresholds were determined using an R-based software package. Gene expression profiles of pancreatic tumors were analyzed from The Cancer Genome Atlas (TCGA).

Results: Higher rVFA was associated with poorer OS only in women ($p = 0.008$, median OS difference of 10 months) and was independent of age, stage, and the presence of chronic pancreatitis. Conversely, nTAMA was associated with poorer OS only in men (median OS difference of 11 months; $p = 0.0004$). Analysis of TCGA gene expression patterns suggest that sex differences in OS are potentially linked to female oxidative phosphorylation and male amino acid metabolism in tumors.

Conclusions: Cancer metabolism can be used to predict patient outcomes in a sex-specific manner.

7:24 AM

DIFFERENTIATING AND SEGMENTING ISOATTENUATING GALLSTONES FROM BILE WITH DUAL-LAYER SPECTRAL CT: AN EX VIVO PHANTOM STUDY

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Purpose: Develop a dual-energy CT (DECT) method for visually segmenting isoattenuating gallstones from bile and compare it to other DECT methods using an ex vivo phantom reader study.

Materials and Methods: Gallstones from 105 cholecystectomy patients were placed inside 120 mL vials containing 5% ox-bile. The vials were scanned in a water-filled phantom with dual-layer DECT. From conventional CT, 30 isoattenuating gallstone vials (gallstone diameters 4.3 to 24.7 mm) and 30 bile-only controls were selected. Six readers evaluated DECT images for the presence of isoattenuating

gallstones on conventional, virtual non-contrast, monoenergetic 200 keV, monoenergetic 40 keV, and segmented images. The segmented images were created using a 2D histogram of Compton and photoelectric attenuation coefficients and custom ROI software.

Results: Segmented images gave the highest mean intrareader (88.1% \pm 7.6%) and interreader agreements (first reading 88.2%, second reading 93.6%), as well as the highest AUC (0.99, 95% CI (0.97, 1.00) all adjusted p values $<$ 0.02) for all 30 gallstones. No significant difference was found between the segmented and monoenergetic images for gallstones with mean diameters $>$ 9 mm (both adjusted P values $>$ 0.05). For gallstones with mean diameters \leq 9 mm the segmented images had the highest AUC (0.99, 95% CI (0.97, 1.00) all adjusted p values $<$ 0.007). The pathology versus segmented image gallstone size mean difference was -0.6 mm (LOA 2.6 to -3.8 mm).

Conclusions: Isoattenuating gallstones can be segmented from bile ex vivo with improved detection (especially those \leq 9 mm diameter) using dual-layer DECT and 2D histograms of Compton and photoelectric attenuations. Detecting isoattenuating gallstones in vivo with DECT could reduce the need for secondary imaging in symptomatic patients with suspected biliary calculi.

7:32 AM

LONG-TERM IN VIVO SURVEILLANCE OF COLORECTAL POLYPS AT CT COLONOGRAPHY: VOLUMETRIC GROWTH RATES ACCORDING TO LESION HISTOLOGY, MORPHOLOGY AND LOCATION

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Purpose: CT colonography (CTC) provides a unique opportunity to study the natural history of colorectal polyps. We report long-term results of in vivo colorectal polyp surveillance in our screening program.

Materials and Methods: Between 2004 and 2018, 450 asymptomatic adults with 629 colorectal polyps underwent follow-up CTC. Of these, 338 polyps in 252 subjects (mean age [\pm SD] at first examination, 61.9 \pm 2.2 years; 142 M/110F) underwent endoscopic resection with pathologic confirmation and represent the study cohort. Mean [\pm SD] CTC surveillance interval was 4.5 \pm 2.3 years. Polyp volumes were derived using a dedicated CTC software application. Growth rates were assessed according to polyp histology, morphology, and segmental location.

Results: Mean volumetric polyp growth rates according to histology were 533%/year for adenocarcinomas ($n = 3$), 156%/year for tubulovillous adenomas (TVA; $n = 31$), 50%/year for tubular adenomas (TA; $n = 197$), 13%/year for sessile serrated adenomas/polyps (SSA/P; $n = 60$), and 13%/year for hyperplastic polyps ($n = 38$). Growth rates according to initial lesion morphology were 81%/year for pedunculated ($n = 22$), 60%/year for sessile ($n = 243$), and 18% for flat ($n = 73$). Growth rates according to segmental location were highest in the descending (120%/year) and rectum (65%/year), lowest in the ascending (33%/year) and transverse (37%/year) colon, and intermediate for the cecum (59%/year) and sigmoid colon (65%/year).

Conclusions: Assessment of volumetric polyp growth at CTC provides a useful biomarker for clinical significance. Lesions with advanced histology (cancer and TVA) and/or polypoid morphology

demonstrate more aggressive growth, whereas serrated and/or flat lesions generally behave in a more indolent fashion.

7:48 AM

FLOW QUANTIFICATION IN PORTAL HYPERTENSION WITH 4D FLOW: COMPARISON OF A FREE-BREATHING k-t ACCELERATED SEQUENCE TO A RESPIRATORY-NAVIGATED SEQUENCE

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Purpose: To compare free-breathing k-t accelerated with standard navigator-gated 4D flow, and to correlate flow parameters with hepatic venous pressure gradient (HVPG).

Materials and Methods: Fourteen initial patients (M/F 8/6, mean age 58 years) with chronic liver disease were prospectively enrolled. 10/14 patients had HVPG measurements within 1 month of MRI. Patients had abdominal MRI at 1.5 T including a respiratory-navigated and a free-breathing k-t accelerated (Cartesian randomly undersampled) 4D flow sequence obtained 10 min. After injection of gadoteric acid. Both coronal-oblique acquisitions (resolution = 2.5³ mm³) covered abdominal vessels with velocity-encoding parameter 60 cm/s. The portal (PV), superior mesenteric (SMV), splenic and middle hepatic veins, the supraceliac aorta and its celiac branches were segmented using prototype software. Time-averaged vessel cross-section area, through-plane velocity and flow were measured.

Results: The k-t accelerated sequence had significantly shorter acquisition time compared to respiratory-triggered sequence (3:11 min \pm 12 s vs. 9:17 min \pm 1:41 min, $p <$ 0.001). Vessels were identified with substantial agreement between sequences (Cohen's kappa = 0.74, $p <$ 0.001). Average flow measurements had substantial agreement in PV and aorta (CV $<$ 15%, bias $<$ 11%, BALA $<$ 50%), and poorer agreement in small vessels such as the hepatic artery (CV = 24%, bias = 24%, BALA = [-52% , 100%]). Average velocity in the SMV measured with the k-t accelerated sequence was positively correlated to HVPG (Pearson $r = 0.85$, $p = 0.03$). No other flow parameters were correlated to HVPG ($p >$ 0.3).

Conclusions: k-t-accelerated 4D flow allows shorter acquisition with equivalent quantification in large hepatic vessels compared to respiratory-triggered acquisition. Flow data will be correlated with degree of portal hypertension in a larger patient cohort.

7:56 AM

PERCUTANEOUS ABLATIVE INTERVENTIONS VS. SURGERY OR TRANSPLANT FOR HEPATOCELLULAR CARCINOMA: A NATIONAL ANALYSIS OF HOSPITALIZATIONS, 1993-2015

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Purpose: To compare population-wide utilization rates of percutaneous liver ablative interventions (IR) versus surgical resection or liver transplant for hepatocellular carcinoma (HCC).

Materials and Methods: Using ICD-9 codes, hospitalizations from 1993 to 2015 for HCC patients were identified in the National Inpatient Sample (NIS) database, the largest inpatient database in the US. Hospitalizations with coexisting secondary hepatic and primary biliary malignancies, neuroendocrine and benign lesions, and liver trauma were excluded. Percutaneous interventions were compared to surgical resection and transplant in utilization rates per year. The effect of demographic and socioeconomic factors on receiving either IR or surgical interventions was evaluated.

Results: A total of 701,368 hospitalizations for HCC were identified with an estimated 35,184 surgical resections (5%), 21,567 (3.1%) transplants, and 17,759 (2.5%) IR procedures. During the 23-year period, hospitalizations increased from 12,178 in 1993 to 54,427 in 2015 with a median annual increase of 4.4% (range, -8.4% in 2000 to 27% in 2007). There are significant disparities between the treatments received in regards to age, gender, racial, income, and insurance coverage. Age greater than 50 (RR 1.4, 95% CI: 1.3–1.5) male gender (RR 1.2, 95% CI 1.2–1.3), Hispanic (RR 1.4, 95% CI 1.3–1.4) or African-American (RR 1.3, 95% CI 1.2–1.4) race, public (vs private) insurance coverage (RR 1.3, 95% CI 1.2–1.3), and non-teaching hospital setting (RR 1.3, 95% CI 1.2–1.3) are significant independent predictors of receiving IR intervention vs surgery, after adjusting for confounders.

Conclusions: There is continued growth in the hospitalizations for hepatocellular carcinoma. Different demographic and socioeconomic factors can affect whether these patients receive IR or surgical procedures.

8:04 AM

SAR 2017 WYLIE J. DODDS RESEARCH GRANT REPORT: MRI TRACKING OF DISTANT TUMOR STIMULATION FROM LIVER RADIOFREQUENCY ABLATION IN A RAT CARCINOMA MODEL USING HYPERPOLARIZED ¹³C-PYRUVATE

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Purpose: Radiofrequency ablation (RFA) is commonly used to treat tumors locally. However, there is evidence that liver RFA can stimulate tumor growth at other sites, a process attributed to the HFG/c-Met pathway. ¹³C MRI may help identify tumors at risk for this effect.

Materials and Methods: Fisher rats were implanted subcutaneously with 10⁷ R3230 adenocarcinoma cells (300 μL). Animals were assigned to 1 of 3 study arms: sham (laparotomy but no RFA, *n* = 9), RFA (right hepatic lobe, 70 ± 2 °C for 5 min, *n* = 13), or RFA + adjuvant c-Met inhibition (PHA-665752, single dose IP, 0.83 mg/kg, administered 24 h post-RFA, *n* = 2). MRI was performed at 9.4 T. ¹³C-pyruvate MRI was performed with an EPSI sequence: FOV 6 cm, 16 × 16 matrix, 3 mm slice thickness. 120

mMol of h¹³C-pyruvate was injected via tail vein. Imaging was performed 24 before and 72 h after treatment. Lactate:pyruvate ratio (LPR) was obtained for each tumor using the average of the three voxels with the highest lactate signal.

Results: RFA alone resulted in increased growth of the R3230 tumor compared to sham (0.50 ± 0.13 mm/day and 0.11 ± 0.07 mm/day, respectively, *p* < 0.0001). In the RFA + adjuvant c-Met inhibition group (RFA + PHA), tumor growth accelerated in the initial 24 h after RFA but declined following PHA administration, with a post-treatment growth rate similar to the sham group (*p* = 0.58). LPR was elevated in the RFA arm relative to the sham arm (*p* = 0.03), and there was no difference between the sham and RFA + PHA arms (*p* = 0.7).

Conclusions: In vivo h¹³C-pyruvate MRI shows increased lactate production within a metastatic tumor model following liver RFA, correlating to stimulated growth. This method could potentially offer a new diagnostic tool in the management of patients undergoing thermal ablation therapies.

8:12 AM

WHOLE-LIVER QUANTIFICATION OF HEPATIC STEATOSIS USING DUAL-ENERGY-COMPUTED TOMOGRAPHY

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Purpose: Investigate a volumetric whole-liver dual-energy computed tomography (DECT) biomarker for hepatic steatosis compared to conventional unenhanced single energy (SECT).

Materials and Methods: IRB-approved HIPAA-compliant retrospective study of consecutive adults (pts) at risk for hepatic steatosis who had standardized multiphase abdominal DECT from 11/28/2011 to 5/10/17, including conventional unenhanced SECT (CU) and arterial phase DECT acquisitions. DECT images were analyzed with volumetric software which automatically segmented the whole liver and generated virtual unenhanced (VUE), fat density maps (FD). 2D hepatic ROIs were populated to identical image locations on DECT and SECT images; 3 ROIs on consecutive slices were averaged, providing 2D mean value. The 3D volumetric whole-liver FD and VUE values were compared to 2D CU mean value. Based on CU measurements, pts were divided into 4 groups: severe (≤ 25HU), moderate (26-40HU), mild (41-55HU), and no steatosis (≥ 56HU). Pearson correlation was used to compare continuous variables; Mann-Whitney (Wilcoxon) test was used to compare separation between the groups.

Results: 639 DECT studies of 548 pts (198 M, 350F, mean age 60) were included: 23% had severe, 34% moderate, 35% mild and 8% no steatosis. Mean 2D value of FD (mg/mL) increased with higher severity of steatosis (severe = 28.5, moderate = 15.6, mild = 7.5, and no steatosis = 2.9; *p* < 0.0001). Similar correlation was observed using 3D values of FD (*p* < 0.0001). Pearson correlation between CU values and 3D FD, CU and VUE, 2D FD and 3D FD values were – 0.89, 0.92, and 0.97, respectively.

Conclusions: DECT whole-liver FD highly correlates with hepatic steatosis measured on unenhanced SECT scans.

8:28 AM**PERFORMANCE OF MORPHOLOGIC CRITERIA FOR DIAGNOSIS OF CIRRHOSIS IN PATIENTS WITH DIFFERENT ETIOLOGIES OF CHRONIC LIVER DISEASE (CLD)**

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Purpose: To investigate sensitivity of morphologic criteria for detection of cirrhosis in alcoholic liver disease (ALD), hepatitis C (HCV), and non-alcoholic steatohepatitis (NASH).

Materials and Methods: This is a retrospective study of 100 patients (53 M, 48 F) with different etiologies of CLD including NASH ($n = 41$), HCV ($n = 39$), and ALD ($n = 20$) with different degrees of fibrosis on liver biopsy. Two readers (R1: 3 years' experience in advanced liver imaging; R2: junior radiology resident) independently analyzed the CT exams performed within 6 months of biopsy for presence of morphologic changes of cirrhosis (surface nodularity, fissural/periportal widening, increased caudate-right lobe ratio) and portal hypertension (splenomegaly, varices, ascites). Each reader assigned an overall score for cirrhosis and portal hypertension. Sensitivity/specificity of morphologic criteria in each etiology group were calculated for each reader and compared using χ^2 test. Frequencies of different morphological changes in each group were compared.

Results: Using morphologic criteria, sensitivity for diagnosis of cirrhosis was significantly lower in NASH (R1: 81%; R2: 63%) compared to ALD (R1: 95%; R2: 90%) and HCV (R1: 85%; R2: 77%) for both readers ($p < 0.001$). The reader with advanced training outperformed the other reader in NASH ($p < 0.001$). Surface nodularity was less common in NASH cirrhosis ($p < 0.001$). Sensitivity for diagnosis of NASH cirrhosis significantly decreased when only patients without portal hypertension were included (58%, $p = 0.003$).

Conclusions: Use of morphologic criteria for diagnosis of cirrhosis had significantly lower performance in patients with NASH. Liver morphology changes in NASH cirrhosis are more subtle and degree of fibrosis could be underestimated when traditional morphologic criteria are used.

8:36 AM**LIVER SURFACE NODULARITY SCORE AS A PREDICTOR OF OVERALL SURVIVAL IN PATIENTS WITH HCC TREATED BY TACE**

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Purpose: To assess the accuracy of the CT-based liver surface nodularity (LSN) score for predicting overall survival (OS) in patients with hepatocellular carcinoma (HCC) treated with trans-arterial chemo-embolization (TACE).

Materials and Methods: For this retrospective study, a search of the electronic medical records was performed to identify adult patients

with HCC treated by TACE within 6 months of a contrast-enhanced abdominal CT. The LSN score was measured using custom software while blinded to clinical data. Age, gender, race, bead size, Barcelona Clinic Liver Cancer (BCLC) stage of HCC (which includes tumor burden/extent, Child–Pugh score, and performance status), time to progression (TTP), and OS were extracted from the electronic medical records. Predictors of TTP and OS were evaluated by Cox proportional hazards ratio.

Results: A total of 165 patients were included with BCLC stage A ($N = 46$), B ($N = 62$), C ($N = 46$), and D ($N = 11$). The mean (standard deviation) of the LSN score was 3.10 (0.71). The median TTP and OS were 10.2 and 21.4 months. None of the variables were predictive of TTP ($p > 0.2$ for each). Predictors of OS included the LSN score (HR 1.41; 95% CI 1.06, 1.88; $p = 0.019$) and age (HR 1.03; 95% CI 1.00, 1.05; $p = 0.029$), but not the BCLC stage of HCC or any of the other variables ($p > 0.10$). For each unit increase in the LSN score, the risk of death increases by 41%.

Conclusions: The CT-based LSN score was an accurate independent predictor of OS in patients with HCC treated by TACE.

8:44 AM**ASSESSMENT OF ADVANCED HCC RESPONSE TO NIVOLUMAB USING STANDARD AND IMMUNE RESPONSE CRITERIA**

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Purpose: To assess the response to anti-PD1 therapy (nivolumab) in patients with advanced HCC using imaging response criteria [RECIST 1.1, modified RECIST (mRECIST) and immune RECIST (iRECIST)].

Materials and Methods: Patients with advanced HCC treated with nivolumab therapy between 8/2015 and 1/2018 were retrospectively assessed. Inclusion criteria were patients treated with nivolumab in whom CT or MRI was performed. Patients who received concomitant locoregional therapy were excluded. Imaging response to therapy was assessed by 2 observers in consensus using RECIST 1.1, mRECIST and iRECIST criteria. Time to progression (TTP) and overall survival (OS) were recorded.

Results: 22 patients [M/F 17/5, mean age 56.3 years, average of 21 nivolumab doses (range 3–55)] met inclusion criteria. Mean duration of nivolumab treatment was 366 days (range 48–842 days). Mean target lesion size at baseline was 5.6 ± 4.8 cm for RECIST1.1/iRECIST and 4.6 ± 4.6 cm for mRECIST. Ten patients had extrahepatic metastases at baseline. OS at 6 m and 9 m was 90.9% and 81.9%, respectively. Median OS was 345 days. Median TTP was 190d (RECIST1.1), 190d (mRECIST), and 240 days (iRECIST) and was due to the development of new lesions in all but one patient. CR(-complete response)/PR(partial response)/SD(stable disease)/PD(progressive disease) rates were 0%/13.6%/18.2%/68.2% for RECIST 1.1 and mRECIST; and iRECIST response for iCR/iPR/iSD/iUPD(unconfirmed PD)/iCPD(confirmed PD) were 0%/13.6%/18.2%/22.7%/45.5%. 10 patients with iUPD progressed to iCPD(OS = 371 days) and 5 remained iUPD(OS = 292 days). There were no cases of pseudoprogression.

Conclusions: Our results demonstrate equivalent to slightly lower objective response rate to nivolumab therapy and no cases of durable CR compared to a recent phase 1/2 trial (Checkmate 040). Nivolumab shows potential for the treatment of advanced HCC.

8:52 AM

PREDICTING MALIGNANCY AND “DIFFICULT TO DETECT” LIVER METASTASES FROM CONTRAST-ENHANCED CT IMAGES USING A DEEP CONVOLUTIONAL NEURAL NETWORK

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Purpose: To automatically predict both malignancy and detection difficulty directly from contrast-enhanced CT images of hepatic lesions.

Materials and Methods: A multi-reader-multi-case study was performed including reference markings and 10 sets of reader markings. There were 102 contrast-enhanced CT exams used, with a reference reader marking hepatic metastases and benign lesions according to predefined reference criteria. 51 of 102 patients had 124 hepatic metastases, and 26 patients had 130 benign lesions. 10 radiologist readers, blinded to the reference and all clinical information, interpreted each exam, circumscribing each lesion and providing a diagnosis. Two sets of labels were then constructed: one binary label of malignancy (using the reference standard), and one of detection difficulty, categorized as “easy” (found by > 25% of readers) or “difficult” (found by < 25% of readers). These labeled images were used to train deep convolutional neural networks (CNNs) to predict malignancy and detection difficulty. A combination of upsampling, data augmentation, transfer learning, and 50% dropout was used to reduce overfitting. Classification performance was tested using a portion of reserved data.

Results: For the lesion metastasis classification, an area under the receiver-operating curve (AUC) of 0.93 and an accuracy of 84% was observed on a reserved sample of 106 lesions. For the lesion difficulty classification, the AUC was 0.94 and an accuracy of 86% was observed on a reserved sample of 44 lesion images.

Conclusions: Both malignancy classification and prediction of detection difficulty may be estimated for contrast-enhanced CT images of hepatic lesions using a deep CNN. This may be used to improve reader performance and reduce variability between radiologists for detecting and diagnosing hepatic lesions.

9:00 AM

THREE-PASS ARTERIAL PHASE WIDE DETECTOR LIVER CT IN PATIENTS WITH ADVANCED CIRRHOSIS: HYPERENHANCING LESION DETECTION AND PEAK CONSPICUITY

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Purpose: To prospectively evaluate wide detector whole-organ axial CT of hyperenhancing liver lesions at three time points during the arterial phase for lesion detection and conspicuity.

Materials and Methods: Thirty-seven patients (24 males, 60 ± 7 years) underwent a multiphase 256-slice liver CT. During the arterial phase, three 16-cm-whole-organ axial passes were performed without table motion at peak aortic enhancement plus 10, 20, and 25 s in addition to standard portal venous and delayed phases (five passes total). On the arterial phase passes we noted lesion detection, ranked conspicuity, measured lesion size, and calculated contrast-to-noise (CNR). With a generalized linear model and Tukey’s post hoc testing, we analyzed statistical differences between the three arterial phase passes.

Results: Of fifty-five hyperenhancing lesions, 38 (69%) showed washout. Average lesion size was 1.87 cm (range 0.7–9.1 cm). Forty-five lesions (85%) were detected on the 10 s arterial pass, 54 (98%) on the 20 s, and 40 (73%) on the 25 s. Peak subjective conspicuity was at 10 s for 13 lesions (24%), at 20 s for 33 lesions (60%), and at 25 s for 9 lesions (16%). There was no statistical difference in CNR between the three arterial passes (6.4, 7.4, 5.9; $p > 0.05$).

Conclusions: The arterial pass at 20 s provided the highest detection rate for hyperenhancing lesions and had the most frequent peak conspicuity. However, 40% of lesions had peak conspicuity at 10 or 25 s. Wide detector CT with multiple arterial phase passes may improve lesion detection and conspicuity.

9:08 AM

NON-HCC PRIMARY HEPATIC MALIGNANCIES ARE MORE LIKELY TO BE MISCATEGORIZED AS LR-5 BY LI-RADS V2017 IN PATIENTS WITH LI-RADS-DEFINED HCC RISK FACTORS

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Purpose: The aim of this study was to determine whether the imaging appearances of intrahepatic cholangiocarcinomas (ICCs) and hepatocellular carcinomas (H-ChCs), as assessed by LI-RADS (LR) v2017, differ between patients with (RF+) versus without (RF–) risk factors for HCC.

Materials and Methods: This retrospective, IRB-approved study included all patients with pathology-proven ICCs or H-ChCs that underwent liver-protocol CT or MRI from 2007 to 2017 at two large liver transplant centers. Patients were defined by LR v2017 criteria as RF+ or RF–, using a composite reference standard consisting of histology, imaging, and laboratory findings. Two independent blinded readers (reader 1 = R1; reader 2 = R2) categorized all lesions (173 ICCs; 92 H-ChCs) using LR v2017.

Results: All LI-RADS major features were significantly *more* common among RF+ patients than RF– patients: arterial phase hyperenhancement (APHE) [R1: 27% vs. 10% ($p = 0.001$), R2: 14% vs. 2% ($p < 0.001$)]; washout [R1: 22% vs. 7% ($p < 0.001$), R2: 12% vs. 2% ($p < 0.001$)]; capsule appearance [R1: 19% vs. 6%

($p < 0.001$), R2: 10% vs. 3% of RF– ($p = 0.014$)). In contrast, several LR-M features were significantly *less* common among RF+ patients than RF– patients: rim APHE [R1: 56% vs. 75% ($p = 0.006$), R2: 78% vs. 90% ($p = 0.014$)]; rim washout [R1: 18% vs. 53% ($p < 0.001$), R2: 4% vs. 17% ($p = 0.006$)]. Consequently, ICCs/H-ChCs were significantly (R1: $p < 0.001$; R2: $p = 0.002$) *more* likely to be miscategorized as LR-5 in RF+ patients than in RF– patients (R1: 15% vs. 3%; R2: 8% vs. 1%).

Conclusions: For LI-RADS v2017, the higher frequencies of major features and lower frequencies of LR-M features among ICCs/H-ChCs in RF+ patients resulted in higher rates of miscategorization as LR-5, an important impediment to the proper classification of these lesions as LR-M in the RF+ population.

9:16 AM

CAN DEEP LEARNING DIFFERENTIATE HCC FROM NON-HCC ON MRI?

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Purpose: Develop a deep learning algorithms than can differentiate HCC from non-HCC on MRI in high-risk patients.

Materials and Methods: One hundred and five lesions in 84 patients at risk of HCC were included in this IRB-approved retrospective study. All patients were imaged with DCE-MRI using gadoxetate or an extracellular agent. Reference standard was histopathology ($n = 76$) (explant, resection, or biopsy) or follow-up MRI ($n = 29$) for ≥ 2 years. 61 HCC and 44 non-HCCs (stable = 24, resolved/smaller = 5, regenerative nodules = 11, biphenotypic tumors = 1, ICC = 2, and hemangioendothelioma ($n = 1$)). Lesions were manually segmented by an abdominal radiologist (4 years in practice) using 3D Slicer (www.slicer.org). Arterial, PVP, and 2-5 min delayed phase images were fed into the image analysis pipeline. All phases were co-registered using deformable registration software (ANTs, <http://stnava.github.io/ANTs/>). Co-registered data was prepared by performing histogram normalization on the entire input volumes and saving a bounding box of each lesion with each phase as a separate channel. Due to the small sample size, data augmentation was performed including random rigid, affine warping and addition of a Gaussian noise filter to simulate different MRI acquisition parameters. A custom CNN architecture (with residual connections in earlier layers) was designed with 22 layers using TensorFlow. Parameters were tuned on 20% of the data and fivefold cross-validation was utilized to generate validation results.

Results: Testing set accuracy was measured at 70%. Area under receiver operating curve (AUC) was measured at 0.68. Sensitivity and specificity was measured at 0.70 and 0.66. PPV and NPV was measured at 0.71 and 0.65, respectively.

Conclusions: CNN can be trained with MRI data to predict the presence of HCC based on MRI appearance but results need further improvement.

HOT TOPICS IN GU SCIENTIFIC PAPER SESSION

7:00 AM

3T MULTIPARAMETRIC MRI: COMPARISON OF PERFORMANCE OF A QUANTITATIVE PI-RADSV1-BASED PROTOCOL WITH A QUALITATIVE PI-RADSV2 FOR PROSTATE CANCER DETECTION, GRADING AND STAGING USING WHOLE-MOUNT HISTOPATHOLOGY AS REFERENCE STANDARD IN 569 PATIENTS WITH 1353 LESIONS

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Purpose: To investigate the performance PI-RADSV2 and a quantitative PI-RADSV1-based scoring system on 3T multiparametric MRI (3TpmMRI) for prostate cancer (PCa) detection, grading & staging with whole-mount histopathology (WMHP) correlation.

Materials and Methods: This HIPAA-compliant, IRB-approved retrospective study, included 569 men with PCa, who underwent 3TpmMRI prior to prostatectomy, 12/2009–10/2017. The performance of a quantitative PI-RADSV1-based protocol (method 1) was compared to PIRADSV2 (method 2), evaluating sensitivity, PPV, grading & staging. In method 1, lesions were assigned an assessment grade based on the formula $(T2WI + 2*ADC + DCE - 0.25*transition\ zone\ (TZ))/4$, where T2WI, ADC, & DCE were 1–5 assessment, & TZ was the binary assessment of TZ (1 if the lesion was in TZ and 0 if not). Method 2 was the standard protocol for PIRADSV2. For both methods, score 3 was considered as low suspicion and scores 4 and 5 were considered as high suspicion for PCa. All 3TpmMRI and histopathology lesions were included and evaluated using STATAv12.

Results: 1353 PCa lesions in 569 patients were included in the study. Methods 1 and 2 had similar sensitivity (44.3% vs. 45%) and PPV (81.2% and 81.5%), respectively. The AUROC for PCa grading (Gleason score 6 vs. > 6) for methods 1 was slightly but non-significantly higher than method 2 (0.67 vs. 0.64)(roccomp command, $p = 0.25$). However, both methods showed similar AUROC for PCa staging ($< T3$ vs $\geq T3$)(0.57 vs. 0.57)(roccomp command, $p = 0.84$).

Conclusions: In this study, the quantitative PI-RADSV1 and qualitative PI-RADSV2 based methods had similar performance for PCa detection, grading and staging.

7:16 AM

VARIABILITY IN CANCER POSITIVE PREDICTIVE VALUE USING PI-RADS V2: A MULTI-INSTITUTIONAL STUDY CONDUCTED BY THE SAR PROSTATE CANCER DISEASE-FOCUSED PANEL (AIM 2)

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Purpose: To determine the variability of positive predictive value (PPV) across centers according to PI-RADS v2 scores.

Materials and Methods: This retrospective IRB-approved, HIPPA-compliant study included 3479 men who underwent prostate mpMRI at 26 DFP-member expert centers from several countries and had a lesion classified as PI-RADS ≥ 2 . Exams scored as PI-RADS 1 (i.e. no visible lesion) were not included. MR-targeted biopsy results were the standard of reference. PPV were derived from generalized estimating equations regression to estimate variability across centers.

Results: Across all centers, the PPV for PI-RADS score ≥ 2 was 33.8% (range: 12.9%, 68.6%), for PI-RADS ≥ 3 was 37.5% (range, 14.7%, 68.6%), and for PI-RADS ≥ 4 , 48.4% (26.4%, 75.9%). The PPV stratified by PI-RADS scores were as follow: score 2 = 6.9% (range, 4.2%, 50.0%); score 3 = 15.3% (3.2%, 54.0%), score 4 = 38.4% (17.7%, 70.0%), and score 5 = 71.9% (40.0%, 97.1%).

Conclusions: Enormous variation in the PPV exists across expert centers, and the overall PPV among these centers was alarmingly low. Based on the results, a PPV $\geq 50\%$ for PI-RADS v2 score ≥ 4 is proposed as a performance standard, with centers below this benchmark warranting quality improvement efforts. Many of the participating centers did not achieve this threshold.

7:24 AM

ROLE OF PI-RADS v2 IN CLINICAL MODELS: A MULTI-INSTITUTIONAL STUDY CONDUCTED BY THE SAR PROSTATE CANCER DISEASE FOCUSED PANEL (AIM 3)

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Purpose: To determine if PI-RADS v2 improves the prediction of high Gleason score prostate cancer beyond PSA, PSA density (PSAD), and clinical stage (T1c versus T2/T3).

Materials and Methods: This retrospective IRB-approved, HIPAA-compliant study included 3479 men who underwent mpMRI of the prostate at one of 26 institutions from the USA, Canada, Brazil, South Korea, and Netherlands. Up to 4 lesions per case were classified using PI-RADS v2. Cognitive, fusion, and in-bore MR-targeted biopsies were performed. Data was collected using REDCap. The impact of PI-RADS v2 on clinical variables was determined using logistic regressions derived area under the ROC curves. Confidence intervals were calculated using cluster-corrected (to account for multiple lesions/person) bootstrapping.

Results: PI-RADS v2 score, logPSA, logPSAD, and palpable nodule were significant predictors of GS $\geq 3 + 4$ on uni- (all $P < 0.001$) and multivariate analyses (logPSA, logPSAD, PIRADS v2 $P < 0.001$, palpable nodule = 0.03). The AU-ROC of PI-RADS v2 alone was 73.9% (72.6%, 75.3%). The incorporation of PI-RADS v2 to the clinical multivariate model raised the AU-ROC from 60.7% (95% CI 59.1%, 62.2%) to 80.8% (95% CI 79.5%, 82.2%). The differences between the AU-ROC of the PI-RADS v2 and combined model (6.8%; 95% CI 5.8%, 7.9%), and of the clinical and combined model (20.1%; 95% CI 19.0%, 21.4%) were statistically significant ($p < 0.001$).

Conclusions: PI-RADS v2 significantly improves the identification of GS $\geq 3 + 4$ prostate cancer when compared to clinical variables, but its performance may be enhanced by the incorporation of PSA, PSAD, and/or knowledge of a palpable nodule.

7:32 AM

EVALUATION OF QUALITATIVE And QUANTITATIVE 3T DCE MRI PARAMETERS IN PROSTATE CANCER LESIONS STRATIFIED BY PATHOLOGY GLEASON SCORE And PIRADSV2 CATEGORY

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Purpose: To investigate the role of qualitative and quantitative DCE-MRI parameters of prostate cancer (PCa) lesions stratified by whole-mount histopathology (WMHP) Gleason score (GS) and PI-RADSv2.

Materials and Methods: This HIPAA-compliant, IRB-approved retrospective study included 323 PCa lesions in 254 men, who underwent 3T-multiparametric MRI prior to prostatectomy, 7/2009–12/2016. Qualitative DCE curve types included type 1 (progressive), type 2 (plateau) and type 3 (washout). Quantitative DCE-MRI pharmacokinetic (PK) parameters included K^{trans} (influx volume transfer coefficient), k_{ep} (efflux reflux rate constant) and iAUC (initial area under the curve). DCE-MRI features of true positive PCa lesions were

evaluated for overall, index, transition zone (TZ) and peripheral zone (PZ), based on GS grade (low = 6, high > 6) and PI-RADSv2. SPSS v24 was used for statistical analysis.

Results: There were 57 (17.6%) low-grade (LG) and 266 (82.4%) high-grade (HG) PCa lesions. PIRADSv2 3, 4 and 5 included 106, 120 and 97, respectively. 251 (77.7%) & 72 (22.3%) lesions were located in PZ and TZ, respectively. Overall and TZ HG lesions had significantly higher proportion of Type 3 curves as compared to LG lesions. As PIRADSv2 increased, the proportion of type 3 curve significantly increased for overall, index and PZ lesions. Among PK parameters, K^{trans} and iAUC for overall & PZ PCa and iAUC for index PCa were significantly higher for HG versus LG lesions. In addition, K^{trans} , k_{ep} and iAUC for overall and PZ PCa and k_{ep} and iAUC for index PCa increased significantly with higher PIRADSv2.

Conclusions: The results of our study show the possible utility of qualitative & quantitative DCE-MRI parameters for assessment of PCa aggressiveness & PIRADSv2 categorization.

7:40 AM

3T MULTIPARAMETRIC MRI: COMPARISON OF CHARACTERISTICS OF MULTI- & SINGLE-ZONAL TRUE POSITIVE INDEX PROSTATE CANCER LESIONS WITH WHOLE-MOUNT HISTOPATHOLOGY CORRELATION IN 408 PATIENTS

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Purpose: To investigate clinical, 3T multiparametric MRI (3TmpMRI) and histopathologic characteristics of multi- and single-zonal true positive index prostate cancer (PCa) lesions with whole-mount histopathology (WMHP) as reference.

Materials and Methods: In this HIPAA-compliant, IRB-approved retrospective study, we evaluated a cohort of 408 men, who underwent 3TmpMRI prior to prostatectomy, from 12/2009 to 10/2017. A genitourinary (GU) radiologist & a GU pathologist reviewed each case to match PIRADSv2 based ROIs to the corresponding locations on WMHP. Index lesion was defined as the lesion with highest GS & if same GS for several tumors, the one with largest diameter. Clinical, MRI & WMHP characteristics of true positive index lesions between multi-zonal (present in both transition (TZ) & peripheral zone (PZ)) and single-zonal (present in either TZ or PZ) PCa lesions were compared using SPSS v24.

Results: 9.3% (38/408) of the lesions were located in both TZ and PZ (multi-zonal), 19.4% (79/408) in TZ and 71.3% (291/408) in PZ. Tumor size was slightly but significantly ($p = 0.002$) higher for multi-zonal (median 2.5 cm) compared to TZ (median 2.3 cm) and PZ lesions (median 2.1 cm). PSA was significantly higher ($p = 0.001$) in multi-zonal (7.7 ng/ml) and TZ (7.65 ng/ml) compared to PZ lesions (6 ng/ml). Multi-zonal lesions had significantly higher proportion of PIRADSv2 score 5 (55.3%) compared to TZ (44.3%) and PZ lesions (33.7%) ($p < 0.001$). PSA density, prostate volume, tumor grading and staging were similar between single and multi-zonal lesions.

Conclusions: Although multi-zonal PCa lesions may have more aggressive 3TmpMRI & clinical characteristics, grading and staging of the tumors on WMHP are similar to single-zonal lesions.

7:48 AM

COMPARATIVE EFFECTIVENESS FOR 18-F FLUCICLOVINE VERSUS PSMA-TARGETED RADIOTRACERS FOR DETECTION OF PROSTATE CANCER BIOCHEMICAL RECURRENCE AFTER DEFINITIVE THERAPY: A SYSTEMATIC REVIEW AND COMPARATIVE META-ANALYSIS

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Purpose: To report comparative meta-analysis results stratified by PSA levels for the detection of biochemically recurrent prostate cancer using 18-F Fluciclovine versus PSMA-targeted radiotracers.

Materials and Methods: Using PRISMA-DTA guidelines, we performed a systematic review of PubMed and EMBASE databases from January 2012 to July 2018. The risk of bias and applicability concerns were assessed using QUADAS-2. Reference standards were pathology, follow-up imaging, or PSA decline after salvage treatment, when available. Pooled estimates and 95% confidence intervals (CI) around the prevalence of a positive exam in the study population were calculated using a random-effects model.

Results: 5113 patients from 43 studies (PSMA) and 939 patients from 7 studies (Fluciclovine) were included. Median PSA was 1.5 g/ml and median age was 68 years. Pooled per-patient detection rates and 95% CI for PSMA and Fluciclovine were 61.3% (52–70%) vs. 43.8% (22–66%) [PSA 0.5–0.99], 78.2% (71–86%) vs. 63.4% (43–84%) [PSA 1.0–1.99], and 93.9% (92–96) vs. 82.0% (64–99) [PSA ≥ 2]. Pooled per-patient detection rate for PSMA at PSA < 0.5 ng/ml was 44.9% (36–54%); no corresponding data was available for Fluciclovine. The positive predictive values were 95.7% (PSMA; 684/715) and 94.5% (Fluciclovine; 291/308) in those with a reference standard. There was substantial study heterogeneity and publication bias.

Conclusions: Patient-level detection rates of PSMA-targeted radiotracers are higher than that of Fluciclovine for the detection of biochemically recurrent prostate cancer when PSA is > 0.5. Paired study designs permitting per-lesion assessment are lacking.

7:56 AM

SAR 2017 MORTON A. BOSNIAK RESEARCH AWARD REPORT: TIME-INTENSITY CURVE ANALYSIS IN CONTRAST-ENHANCED ULTRASOUND EVALUATION OF EPHB4 AS A THERAPEUTIC TARGET IN THE TREATMENT OF BLADDER UROTHELIAL CARCINOMA

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Purpose: To evaluate response to therapy of bladder cancer treated with neoadjuvant sEphB4-HSA using contrast-enhanced ultrasound (CEUS) with time-intensity curve (TIC) analysis, by evaluating changes in TIC parameters between pre- and post-treatment scans.

sEphB4-HSA is a novel anti-angiogenic agent, known to decrease tumoral microvascular density.

Materials and Methods: Recipient of the SAR 2017 Morton A. Bosniak Award, this study was planned as a CEUS TIC study on a cohort of RCC patients. Enrollment for this cohort is delayed, and so we present preliminary results from a different cohort. 10 patients with bladder cancer will receive neoadjuvant sEphB4-HSA prior to cystectomy, and will undergo bladder mass CEUS both before and after neoadjuvant therapy. We will quantify changes in TIC parameters between pre- and post-treatment scans: rise time (RT), time to peak (TTP), wash-in slope (WIS), and peak intensity (PI). We will correlate imaging results with changes in microvessel density from pathological specimens. At the date of this submission, we have completed pre- and post-treatment CEUS for 2 patients.

Results: Between pre- and post-treatment, patient 1 showed an increase in RT from 5.7 to 7.9 s, an increase in TTP from 20.2 to 27.0 s, a decrease in WIS from 2.2 to 2.0 dB/s, and an increase in PI from 14.0 to 17.3 dB. Similarly, patient 2 showed an increase in RT from 3.4 to 15.4 s, an increase in TTP from 18.9 to 31.6 s, a decrease in WIS from 2.0 to 1.5 dB/s, and an increase in PI from 7.6 to 25.9 dB.

Conclusions: Preliminary results show that treatment with sEphB4-HSA produced quantifiable changes in TIC parameters. Increase in RT and TTP, and decrease in WIS, were observed and reflect the expected anti-angiogenic effect. We will complete this cohort and then perform the same study with an RCC cohort.

8:12 AM

QUANTITATIVE MRI RADIOMICS FEATURES FOR CHARACTERIZATION OF RCC SUBTYPES

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Purpose: To assess the value of quantitative MRI radiomics features for the characterization of subtypes of solid renal cell carcinomas (RCCs).

Materials and Methods: In this retrospective study, we included patients that underwent MRI before total or partial nephrectomy between June 2015 to June 2018 for renal neoplasm. One index lesion was analyzed per patient. Regions of interest were drawn on T1 pre-contrast, arterial phase (AP), and nephrographic phase (NP) post-contrast. Histogram and Haralick texture features were used for quantitative characterization, and Mann–Whitney *U* test, ROC, and logistic regression were used for differentiation of RCC subtypes.

Results: We report preliminary results in 37 out of 120 patients with renal neoplasm. Mean age was 55.3 years, 73% were males. Mean lesion size was 3.5 cm (range 1.2–12.2 cm). There were 18 clear cell RCCs (ccRCC), 12 papillary, 4 chromophobe and 4 tubulo-papillary RCC subtypes. We observed differences between ccRCC vs. other RCC subtypes using two histogram parameters (skewness and standard deviation (SD)) at NP ($p = 0.045$ and $p = 0.049$, respectively), as well as in 1 AP texture-feature ($p = 0.025$). These same features were also found to be discriminant predictors in differentiating ccRCC from other subtypes with an AUC of 0.696 for skewness

($p = 0.048$), 0.699 for SD ($p = 0.044$), and 0.722 for texture ($p = 0.025$). Logistic regression with stepwise feature selection showed an AUC of 0.892 ($p < 0.001$) when combining SD (pre-contrast and NP) and texture at NP for diagnosing ccRCC.

Conclusions: MRI radiomics features may help in characterizing RCC subtypes. These preliminary findings need to be validated in larger cohorts in comparison with standard criteria.

8:20 AM

CONTRAST-ENHANCED CT PERFORMED IMMEDIATELY AFTER THERMAL ABLATION OF RCC IS SAFE

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Purpose: To evaluate the impact of iodinated contrast on glomerular filtration rate (eGFR) given immediately after thermal ablation of cT1a RCC.

Materials and Methods: Informed consent was waived for this HIPAA-compliant multicenter retrospective study. Three hundred forty-two consecutive patients with cT1a biopsy-proven RCC had percutaneous microwave (MW) or radiofrequency (RF) ablation between January 2010 and December 2017. Age, gender, ethnicity, tumor size and histology, RENAL nephrometry score and pre- (within 1 month) and post-procedure (at 6 months) eGFR data were collected. Patients were classified into two groups: those who received a contrast-enhanced CT (CECT) immediately after the ablation to confirm treatment success and those who did not (control). A 1:1 propensity score matched cohort analysis with multivariate analysis of effects was performed with post-ablation eGFR as the primary outcome. Stepwise multivariate logistic regression was performed to identify risk factors associated with change in eGFR after ablation.

Results: Two hundred forty-five patients (157 M/88 F; median age 69 years, IQR 62–74) with pre- and post-procedure eGFR were included. Fifty-two patients had a baseline eGFR below 45 ($n = 28$, control group). Except for a greater number of patients with a solitary or transplant kidney in the control group ($p = 0.004$), demographics and comorbidities were similar ($p > 0.05$). Median tumor size (2.4 vs. 2.5, $p = 0.21$) and RENAL scores (6 vs. 6, $p = 0.85$) were similar. Thermal ablation caused a mild reduction in eGFR of 14% for the control ($p < 0.0001$) and 4% for the contrast groups ($p = 0.03$). IV contrast administered during ablation had no effect on eGFR regardless of baseline renal function (2.03, 95% CI – 3.36 to 7.41).

Conclusions: Contrast-enhanced CT performed in conjunction with renal ablation is safe.

8:28 AM

APPLICATION OF ITERATIVE METAL ARTIFACT REDUCTION ALGORITHM TO TRIPHASIC COMPUTED TOMOGRAPHY UROGRAPHY TO IMPROVE IMAGE QUALITY

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Purpose: To compare the image quality of triphasic CT urography in patients with metal hip prostheses or spinal instrumentations reconstructed using iterative reconstruction (IR) alone and IR with iterative metal artifact reduction (IMAR).

Materials and Methods: This retrospective study included triphasic CT urography studies of 48 patients (with hip prosthesis $n = 34$; spinal instrumentation $n = 12$; both $n = 2$) which were reconstructed using IR alone and IR with IMAR. Image quality was assessed subjectively and objectively. For subjective analysis, images were evaluated for the degree of artifacts and for the confidence in visualizing kidney, ureter and bladder. For objective analysis; in patients with hip prosthesis, regions of interest (ROIs) were placed within the bladder; in patients with spinal instrumentations, ROIs were placed within the peripelvic/periureteric fat at the slice with the strongest metallic artifact. CT attenuation and standard deviation values were recorded. To determine the diagnostic performance, all images were analyzed for pathological findings and confidence score was determined. To compare variables Wilcoxon signed-rank test and paired t test were used.

Results: The metal artifacts were reduced and visualization of the bladder and ureter were improved with iMAR ($p < 0.05$). In patients with hip prostheses, the diagnostic performance was improved and the image noise within the bladder was significantly lower with IMAR ($p < 0.001$). In patients with spinal instrumentations, no significant difference was found in visualization of the kidneys ($p > 0.05$), in the image noise for peripelvic or periureteral fat ($p > 0.05$) and in diagnostic performance ($p > 0.05$) with regards to urinary system pathologies.

Conclusions: The use of iMAR with triphasic CT urography may improve diagnostic performance in patients with metal artifacts.

8:52 AM

UTILITY OF TRANSVAGINAL ULTRASOUND IN WOMEN WITH HIGH RISK FOR TUBO-OVARIAN CARCINOMA

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Purpose: Screening with transvaginal ultrasound (TVUS) prior to risk reducing salpingo-oophorectomy (RRSO) is recommended for women at high risk for tubo-ovarian carcinoma (TOC). This study examines adnexal radiologic–pathologic correlation and the utility of TVUS in identifying malignant lesions.

Materials and Methods: This IRB-approved, HIPAA-compliant retrospective study included adult women at high risk for TOC who had TVUS within 6 months of RRSO. Pathology results were reviewed. TVUS images were interpreted in consensus by expert readers blinded to final diagnosis. Diagnostic performance of TVUS was analyzed.

Results: 147 women with ages 28–75 (mean 48.5) were included. Known genetic mutations (BRCA1, BRCA2, Lynch syndrome, BRIP1, RAD51D) were noted in 137 women and 10 had other high-risk history. Final pathology reports showed 129 (88%) had benign non-neoplastic results, 11 (8%) had benign neoplasms, 5 (3%) had malignant neoplasms, and 2 (1%) had high-risk precursor lesions. 3 of 5 cancers and all high-risk precursors were isolated to fallopian tubes. TVUS results were normal/benign in 95 women (64%) and abnormal in 11 (8%), while one or both ovaries were not visualized in 41 (28%). Hydrosalpinx was absent on TVUS in all tubal cancers. TVUS had

28.5% sensitivity, 64.2% specificity, 3.8% PPV, 94.7% NPV for TOC or high-risk precursor.

Conclusions: TVUS had a low sensitivity for detecting TOC and tubal precursors in high-risk women. These findings, and emerging understanding of the tubal origin of cancer in high-risk women, underscore the need for development of new screening technologies.

9:00 AM

PROSPECTIVE LONGITUDINAL EVALUATION OF PELVIC RECOVERY AFTER ENDOMETRIAL CANCER: MRI AND PATIENT-REPORTED SEXUAL AND PELVIC FLOOR FUNCTIONAL OUTCOMES

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Purpose: Most women with endometrial cancer (EC) have an excellent prognosis and may be cured. However, treatment-related pelvic functional impacts may affect long-term quality of life. To better understand these concerns, we explored correlations between patient-reported outcomes and pelvic magnetic resonance imaging (MRI) features in women treated for EC.

Materials and Methods: Women with histologic diagnosis of EC were consented preoperatively and completed the validated Female Sexual Function Index (FSFI) and Pelvic Floor Dysfunction Index (PFDI) questionnaires at pre-operative, 6-week, and 6-month follow-up visits. Pelvic MRIs with dynamic pelvic floor sequences were performed at 6 weeks and 6 months.

Results: From 2016 to 2018, 33 women participated. Only 53.7% had been asked about sexual function by providers while 92.4% thought they should have been. Sexual function became more important to women over time. Baseline FSFI was low, declined at 6 weeks, and climbed above baseline at 6 months. Hyperintense vaginal wall signal on T2WI (10.9 vs. 4.8, $p = 0.002$) and intact Kegel function (9.8 vs. 4.8, $p = 0.03$) were associated with higher FSFI. PFDI scores trended toward improved pelvic floor function over time. Pelvic adhesions on MRI were associated with better pelvic floor function (23.0 vs 54.9, $p = 0.003$). Urethral hypermobility (48.4 vs. 21.7, $p = 0.01$), cystocele (65.6 vs. 24.8, $p < 0.0001$), and rectocele (58.8 vs. 18.8, $p < 0.0001$) predicted worse pelvic floor function.

Conclusions: Use of pelvic MRI to quantify anatomic and tissue changes may facilitate risk stratification and response assessment for pelvic floor and sexual dysfunction. Patients articulated the need for attention to these outcomes during cancer treatment.

AT THE CUTTING EDGE SCIENTIFIC PAPER SESSION

10:08 AM

ARTIFICIAL INTELLIGENCE FOR ABDOMINAL ULTRASOUND: A ROBUST NEW TOOL TO PREDICT FATTY LIVER

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Purpose: To non-invasively identify steatosis from ultrasound images of the liver using convolutional neural networks (CNNs), the current state-of-the-art algorithm for image-based artificial intelligence (AI).

Materials and Methods: The dataset comprised 624 retrospectively collected ultrasound images obtained during biopsy from 354 patients undergoing random liver biopsies between 2009 and 2013. Two outcomes were defined based on pathology: no steatosis (0%) vs. steatosis (> 0%) and zero-to-mild steatosis (< 5%) vs. mild-to-severe steatosis (> 5%). Ultrasound images were preprocessed by a CNN to isolate the ultrasound image from surrounding annotations. Additional CNNs were trained on the resulting images to predict the outcomes described above. AI performance was evaluated by tenfold double cross-validation using the area under the receiver operating characteristic curve (AUROC) as the evaluation metric.

Results: For 0% steatosis vs. > 0% steatosis, our AI achieved an AUROC of 0.738, 95% CI (0.685, 0.792); whereas for < 5% steatosis vs. > 5% steatosis, our AI achieved an AUROC of 0.784, 95% CI (0.734, 0.835). Our previous published work using texture analysis (< 5% vs. > 5% steatosis) achieved an AUROC of 0.71, 95% CI (0.67, 0.74) and required manual delineation of a region of interest in each image by a board-certified radiologist.

Conclusions: Liver steatosis can be detected directly from ultrasound imaging using AI with minimal human involvement. Using ultrasound, this is a much more accessible assay than similar measurements from CT or MR. We expect that our AI performance will further improve with additional training data and diagnostic-quality images. This approach is scalable to large amounts of data and can be extended to other pathologies and modalities.

10:16 AM

MACHINE-LEARNING PREDICTION OF LIVER STIFFNESS USING CLINICAL AND T2-WEIGHTED MRI RADIOMIC DATA

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Purpose: To develop a machine-learning model to categorically classify MR elastography (MRE)-derived liver stiffness using clinical and non-stiffness MRI radiomic features in pediatric and young adult patients with known/suspected liver disease.

Materials and Methods: IRB approval was obtained for this retrospective study. Clinical data (27 demographic/anthropomorphic, medical history, and laboratory features), MRI radiomic data (105 features), MRI presence of liver fat/chemical shift-encoded fat fraction, and MRE mean liver stiffness measurements were obtained from 309 patients (mean age = 14.0 ± 5.0 years). Radiomic features were extracted from T2-weighted fast spin echo images. Patients were categorized by mean liver stiffness (< 3 kPa vs. ≥ 3 kPa). Support vector machine (SVM) models were implemented to perform two-class classification using clinical features alone, radiomic features alone, and the combination of clinical and radiomic features. Diagnostic performance was assessed using accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC) with a leave-one-out cross-validation strategy.

Results: Thirty features (13 clinical, 17 radiomic) were selected for classifying liver stiffness. The combination of clinical and radiomic features produced the best performance (AUC = 0.85) compared to clinical (AUC = 0.81) or radiomic (AUC = 0.76) features alone. Using both clinical and radiomic features, the SVM model was able to correctly classify patients with 83.2% accuracy, 74.1% sensitivity, and 88.3% specificity. AUC increased to 0.88 when excluding patients with fatty liver disease.

Conclusions: An SVM machine-learning model incorporating clinical and T2-weighted radiomic features may provide a means of categorically classifying liver stiffness and directing the use of MRE.

10:32 AM

CT TEXTURE ANALYSIS OF LARGE RENAL CELL CARCINOMA: COMPARING THE PERFORMANCE OF TWO TEXTURE ANALYSIS SOFTWARE PLATFORMS

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Purpose: Computed tomography texture analysis (CTTA) analyzes the quantity and distribution of gray-level pixel data from routinely obtained cross-sectional imaging. It has been shown to be associated with tumor histology and disease outcomes. Multiple CTTA platforms exist though little comparison data is available. We compare the ability of two CTTA platforms to predict histopathology and survival of patients with large (> 7 cm) renal cell carcinoma (RCC).

Materials and Methods: Texture analysis was performed on raw pre/post-contrast multidetector CT (MDCT) images of untreated RCC tumors in 141 patients (95 male, 46 female, mean age 60) using TexRAD (Somerset, UK), which analyzes a single 2-D tumor slice, and Healthmyne (Madison, WI), which analyzes the entire 3-D tumor volume. Metrics were correlated with histologic subtype and clinical outcomes.

Results: In the portal venous (PV) phase, entropy and standard deviation from both platforms were strongly associated with clear cell histology ($p < 0.001$). Volumetric analysis with Healthmyne revealed similar associations for advanced metrics, including gray-level co-occurrence matrix (GLCM) entropy, GLCM energy and sphericity. ROC analysis of SD vs. histology revealed greater AUC for Healthmyne (0.86) than Texrad (0.80). Healthmyne volume and texture features of unenhanced CT predicted death due to disease (HR, mean = 1.09, 95% CI 1.03–1.15, $p = 0.004$), death from all causes, and disease recurrence.

Conclusions: Individual features from both texture platforms were associated with clinical and histological features, suggesting that these findings are not spurious or solely related to technology used. Predictive accuracy for RCC histology was higher for Healthmyne analysis. Advanced secondary GLCM metrics from Healthmyne may be predictive of tumor characteristics and clinical outcomes.

10:40 AM

UTILITY OF TEXTURE AND NEURAL NETWORK ANALYSIS TO DISTINGUISH HOMOGENEOUS PAPILLARY RENAL CELL CARCINOMA FROM HYPERDENSE RENAL CYSTS

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Purpose: To use texture and neural network analysis to distinguish homogeneous papillary renal cell carcinomas (pRCCs), the most common homogeneous renal malignancy, from hyperdense renal cysts, on single-phase contrast-enhanced CT.

Materials and Methods: This was a retrospective HIPAA-compliant study. 37 histologically proven pRCCs with homogeneous appearance in the corticomedullary, nephrographic or portal venous phase, and 49 hyperdense renal cysts (as confirmed by ultrasound or MRI) with imaging in the portal venous phase were identified. A single axial image from the center of the lesion was exported and the lesion was segmented. 38 texture features, including 20 gray-level co-occurrences, 11 gray-level run-lengths, and 7 Hu's moments were calculated for each lesion using Matlab. K-nearest neighbor (KNN) and support vector machine (SVM) classification were performed in Matlab using all 38 texture features. Tenfold cross-validation testing was used to calculate area under receiver-operating curve (AUC), sensitivity, specificity, and positive- and negative-predictive values (PPV, NPV) for detection of pRCCs.

Results: Individual texture parameters were inaccurate in distinguishing pRCC from hyperdense cysts (AUC < 0.75). KNN classification had AUC, sensitivity, specificity, PPV and NPV of 0.78, 0.75, 0.78, 0.80 and 0.72, respectively, for detection of pRCCs. SVM classification had AUC, sensitivity, specificity, PPV and NPV of 0.77, 0.71, 0.71, 0.75 and 0.67, respectively, for detection of pRCCs.

Conclusions: Texture and neural network analysis have the potential to distinguish solid homogeneous renal masses from hyperdense renal cysts on single-phase contrast-enhanced CT and could obviate the need for costly additional imaging workup of hyperdense cysts.

10:48 AM

RADIOGENOMICS IN POLYCYSTIC KIDNEY DISEASE

Timothy Kline, Tahj Alli-Balogun, Marissa Lee, Sruthy Vellat Puthanveedu, Marie Edwards, Andrew Metzger, Daniel Adamo, Theodora A. Potretzke, Bernard F. King, Peter Harris, Vicente E. Torres, Bradley J. Erickson

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Purpose: Genotypic variants of autosomal-dominant polycystic kidney disease (ADPKD) include *Pkd1* and *Pkd2*. Patients with mutations in *Pkd2* typically have milder disease, and for *Pkd1*, truncating mutations (vs. non-truncating) correlate with renal survival (*PKD1-trunc* are typically more severe). However, these genotypic variants have a wide phenotypic range. This project aims to create an

artificial intelligence-based technique that can predict genotypic variants from MR images.

Materials and Methods: Our dataset included abdominal T2-weighted MR scans and corresponding kidney segmentations as well as the genetic mutation status for 204 Patients (107 *PKD1-trunc*, 59 *PKD1-non-trunc*, and 38 *PKD2*). Both classical machine-learning (where image features are computed and fed to a learning model) and deep learning (where image features are learned by the model) were applied to train a computer to predict genetic mutation from imaging.

Results: Many MR texture parameters differed significantly between *PKD1-trunc* and *PKD2* patients. For example, entropy (a measure of image disorder) was greater in *PKD1-trunc* patients ($p \ll 0.05$). The supervised classification (SVM) had a mean area under ROC curve of 0.83 (in terms of distinguishing *PKD1-trunc* from *PKD2*). In unsupervised learning (K-means with two clusters) one cluster contained 77% of the *PKD2* patients. The deep learning approach (18-layer residual-CNN) reached an accuracy of 76.9% (distinguishing *PKD1-trunc* from *PKD1-non-trunc*).

Conclusions: Using MR images alone, we created an automated method for predicting underlying genetic mutations from MR images. Identifying consistent visual characteristics of different genotypic variants could potentially help elucidate disease mechanisms and inform treatment decision-making.

10:56 AM

INTRAHEPATIC CHOLANGIOCARCINOMA: PREDICTION OF CLINICAL OUTCOMES USING QUALITATIVE IMAGING AND RADIOMICS TEXTURE ANALYSIS

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Purpose: To assess the diagnostic performance of qualitative features and radiomics texture features for the prediction of histopathology and clinical outcomes of intrahepatic cholangiocarcinoma (ICC).

Materials and Methods: Seventy-four patients (27 M/47 F, mean age 62.8 years) with 74 ICCs with pre-operative computed tomography (CT, $n = 37$) and/or magnetic resonance imaging (MRI, $n = 52$) within 6 months of resection were included in this retrospective study. Qualitative tumor features were assessed. Haralick texture features were computed. Clinicopathologic data and imaging features were compared with tumor grade, AJCC stage, and time to recurrence (TTR) using the log-rank test, Cox proportional hazards regression and logistic regression analysis.

Results: Median TTR was 21.4 months (range, 28–4177 days). ICC recurred in 45 patients (60.8%). For two readers, the presence of satellite lesions (CT: $p = 0.013$; HR 2.51 [1.21–5.17]; $p = 0.001$, HR 3.39 [1.61–7.12]; MRI: $p = 0.003$, HR 6.60 [1.95–22.41], $p = 0.023$, HR 4.73 [1.24–18.09]) and macrovascular invasion (CT: $p = 0.024$, HR 2.25 [1.11–4.54]; $p = 0.047$, HR 2.01 [1.01–4.01]; MRI: $p = 0.001$, HR 5.63 [1.96–16.16]; $p = 0.001$, HR 9.23 [2.64–32.28]) were predictive of TTR. Several CT and MRI texture features, including MRI difference variance ($p = 0.038$, HR $> 10^5$ [1.82– $> 10^9$]) and MRI difference entropy ($p = 0.015$, HR 80.92 [2.36–2779.55]), were strong predictors of TTR. Serum CA 19–9

($p = 0.002$, HR 2.84 [1.47–5.49]), metastatic lymph nodes ($p = 0.005$, HR 2.51 [1.32–4.77]), and AJCC stage ($p = 0.004$, HR 1.45 [1.13–1.87]) were predictive of TTR. No combination of clinical or imaging variables was predictive of tumor grade.

Conclusions: Imaging features including radiomics parameters are strong predictors of TTR in ICC, compared to AJCC stage and serum CA 19-9.

11:04 AM

SAR 2017 HOWARD S. STERN RESEARCH GRANT REPORT: IMAGING OF ZINC METABOLISM USING HYPERPOLARIZED ¹³C MAGNETIC RESONANCE IMAGING

Sinan Wang, David E. Korenchan, Celine Taglang, Thomas Hayes, Renuka Sriram, Robert Bok, Paola Perez Rivera, Andrew Hong, Henry Li, Zhen J. Wang, David M. Wilson, John Kurhanewicz, Robert Flavell

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Purpose: Alterations in zinc homeostasis are implicated in disease states including prostate cancer, diabetes, and neurodegenerative diseases. We have developed a method of imaging zinc concentration using hyperpolarized ¹³C MRI using new probes, cysteine and iminodiacetic acid, and validated their performance in phantom experiments.

Materials and Methods: Candidate zinc binding probes cysteine and iminodiacetic acid were synthesized and their polarization parameters were optimized. HP imaging of zinc was verified in an imaging phantom on a Bruker BioSpec 3T preclinical MRI scanner using 2D chemical shift imaging (CSI) pulse sequence.

Results: We found that cysteine (Cys) and iminodiacetic acid (IDA) represented promising zinc sensors for HP-MRI. The ¹³C labeled carboxylates NMR resonances of Cys and IDA demonstrated a chemical shift change of +5.2 and +7.5 ppm, respectively, in the presence of equimolar Zn. In HP phantom imaging assays, Cys showed a linear response to zinc concentration with a sensitivity limit of 200 μ M of zinc, well within the range of physiologic levels. The method could be used to measure Zn concentration in a rat prostate extract. The result obtained using the imaging method (950 μ M) matched well with the measurement using a commercial fluorescence assay (932 μ M).

Conclusions: These data demonstrate that Cys and IDA represent promising probes for imaging zinc biodistribution using hyperpolarized ¹³C MRI. These probes can be used to accurately measure zinc concentration in tissue extracts. Ongoing experiments in the laboratory are focused on evaluation in abdominal imaging applications including pancreatic and prostate imaging in mouse models.

11:12 AM

ROBUSTNESS OF FIRST-ORDER TEXTURE FEATURES ON 3T LIVER MRI

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Purpose: To determine the impact of DWI and T2WI acquisition parameters on first-order hepatic texture measures at 3T MRI.

Materials and Methods: Five healthy volunteers (3 M/2F, mean 40 years old) were prospectively imaged at 3T using baseline liver free-breathing DWI and T2WI acquisition twice to assess scan-rescan repeatability. Three modifications to acquisition parameters were also performed individually: decreased averages (2 vs. 4); lower resolution (DWI: 128x96 vs. 192x144 and T2WI: 192x192 vs. 320x320); and increased slice thickness (8 vs. 4 mm). A single reader placed four co-registered hepatic ROIs using 3D Slicer v4.8.1 (www.slicer.org). 10 first-order histogram texture features (average of the four ROI) were compared to baseline acquisition. Percent difference (%diff) and coefficient of variance (CV) were computed using MedCalc.

Results: For ADC, 8 out of 10 parameters were repeatable with < 10% scan-rescan %diff; Skewness and Minimum were least repeatable with > 10% scan-rescan %diff. Entropy was the only parameter that had < 10% CV and %diff for all acquisition schemes; all other parameters had > 10% CV for at least one modified acquisition scheme. Skewness, Minimum, and Variance had the largest average CV. Change in slice thickness had the largest impact on most texture features.

For T2WI, 9 out of 10 parameters were repeatable with < 10% scan-rescan %diff; Skewness had > 10% scan-rescan %diff. Entropy and Uniformity were the only two parameters that had < 15% CV and %diff for all acquisition schemes. Change in slice thickness had the largest impact on most texture features.

Conclusions: ADC and T2WI first-order hepatic texture features, except for entropy, depend on acquisition parameters. Care must be taken to maintain identical acquisition schemes to compare changes in these features, such as after treatment.

11:20 AM

FULLY AUTOMATED ANALYSIS OF ABDOMINAL CT SCANS FOR OPPORTUNISTIC PREDICTION OF CARDIOMETABOLIC EVENTS: INITIAL RESULTS IN A LARGE ASYMPTOMATIC ADULT COHORT

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Purpose: To apply a battery of trained and validated CT-based machine-learning algorithms to a large screening cohort for predicting future “cardiometabolic” events.

Materials and Methods: Fully automated abdominal CT-based algorithms for assessing (1) aortic calcification, (2) muscle mass/attenuation, (3) visceral/subcutaneous fat, and (4) bone mineral density (BMD) were validated and then tested on an asymptomatic cohort of 9305 adults (mean age, 57.1 years; 4111 M/5194 F) undergoing colonography screening. Post-CT clinical follow-up was performed to document subsequent cardiovascular events (e.g., MI, CVA), fragility fractures, and death.

Results: Over the entire follow-up interval (mean, 7.9 years; up to 14.0 years), cardiovascular events, fragility fractures, and death were documented in 1569 (16.7%), 646 (6.9%), and 549 (5.9%) individuals, respectively. With few exceptions, most calcification, muscle, fat, and BMD measures differed significantly ($p < 0.0001$) between those

positive vs. negative for the three primary outcomes (CV events, fractures, and death). For example, higher aortic Agatston scores correlated with CV events (mean, 1731 vs. 759) and death (mean, 2553 vs. 831). Similarly, higher visceral fat scores correlated with CV events (mean, 202 vs. 161 cm²) and death (205 vs. 166 cm²). BMD, fat, and muscle measures all correlated with fragility fractures ($p < 0.0001$), but aortic calcification did not. Subcutaneous fat did not correlate with any of the main outcomes.

Conclusions: The automated CT-based measures described herein can serve as valuable biomarkers for cardiometabolic risk profiling. These measures could be applied opportunistically to CT scans performed for a wide variety of clinical indications, ultimately providing output in terms of 5-year or 10-year risk.

11:28 AM

FULLY AUTOMATED ANALYSIS OF BODY COMPOSITION FROM ROUTINE CLINICAL ABDOMINAL CT IS ASSOCIATED WITH OVERALL SURVIVAL IN AN UNSELECTED OUTPATIENT POPULATION

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Purpose: Body composition (BC) is associated with survival in cancer and cardiovascular disease. We investigate whether fully automated BC analysis of abdominal CT is associated with survival in an unselected outpatient population.

Materials and Methods: Following IRB approval, 2500 exams were randomly selected from outpatient abdominal CTs performed at three affiliated sites in 2012. Clinical data were obtained from the EMR. DICOM files were retrieved from PACS and analyzed by our machine-learning model to determine the subcutaneous fat (SF), visceral fat (VF) and skeletal muscle (SM) areas from a slice at L3, which were then normalized by height. Each study was reviewed for series selection, slice selection and BC segmentation. Spearman correlation coefficients were calculated between BC areas and weight. Two-year survival was analyzed with BC areas, BC indices and weight using Cox proportional hazards models.

Results: Patients had a mean age of 57 yr (SD 16 yr). 53.7% were female and 46.3% were male. 79.9% were White non-Hispanic, 6.1% Black, 3.2% Asian, and 0.3% Hispanic, with the remainder of other or unknown race.

In unadjusted models, 2-year survival was associated with SM area ($p < 0.0001$), SM index ($p < 0.0001$), SF area ($p < 0.0001$) and SF index ($p = 0.0006$). Two-year survival was not significantly associated with VF area ($p = 0.0693$) or VF index ($p = 0.5505$).

The calculated BC areas correlate significantly with patient weight/BMI ($p < 0.0001$), however, in a combined 2-year survival model including BC areas, weight, and demographics, only SM area and demographics remained significantly associated.

Conclusions: Automated CT-based BC analysis holds major potential to provide latent value from routine CT imaging for patients and ordering providers. Our results show that automated CT-based BC analysis is associated with 2-year survival.

11:36 AM**EFFECT OF AN AUTOMATED COMPUTERIZED DECISION SUPPORT SYSTEM IN CT IDENTIFICATION OF COMPLETE RESPONSE OF MUSCLE-INVASIVE BLADDER CANCER TO NEOADJUVANT CHEMOTHERAPY**

Richard H. Cohan, Kenny Cha, Lubomir Hadjiyski, Elaine M. Caoli, Matthew S. Davenport, Prasad R. Shankar, Isaac R. Francis, Kimberly L. Shampain, Daniel Barkmeier, Meyer B. Nathaniel, Sean Woolen, Ajjai Alva, Alon Weizer, Heang-Ping Chan

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Purpose: To determine whether a CT-based computerized decision support system (CDSS) improves CT identification of complete response of muscle-invasive bladder cancer (MIBC) to neoadjuvant chemotherapy.

Materials and Methods: In this IRB-approved HIPAA-compliant study, CTs of 123 subjects with 157 MIBCs were analyzed with a CDSS employing deep-learning convolutional neural network and radiomic features. Five abdominal radiologists, four radiology residents, two oncologists, and one urologist estimated the likelihood of complete response (T0 disease) by viewing paired pre and post-treatment CTs. Observers provided independent estimates and then were permitted to revise their estimates after consulting a CDSS generated 10-point complete tumor response likelihood score. Predictions were compared with findings at subsequent cystectomy, with CDSS scores of 5 excluded.

Results: For the 12 physicians, the mean AUC for predicting post-treatment T0 disease was 0.74 (range 0.66–0.78). When physicians were asked to read after being informed of the CDSS generated T0 likelihood score, the AUC increased to 0.77 (range 0.73–0.81) ($p < 0.05$). For CDSS alone, the AUC was 0.80. Only one physician performed better than CDSS alone. When CDSS alone indicated T0 disease, it was correct 27/68 times (NPV = 40%). When CDSS indicated > T0 disease, it was correct 70/75 times (PPV = 93%).

Conclusions: Use of CDSS improves physician performance identifying complete response of MIBC to neoadjuvant chemotherapy on CT; however, the system on its own performs better than the majority of physicians evaluating treated bladder cancers. CDSS prediction of > T0 disease is more reliable than CDSS prediction of T0 disease.

11:44 AM**CHANGE IN SALVAGE THERAPY MANAGEMENT BASED ON 18F-FACBC (FLUCICLOVINE) PET/CT IMAGING RESULTS IN PATIENTS WITH BIOCHEMICAL RECURRENCE OF PROSTATE CANCER: A SINGLE-CENTER EXPERIENCE**

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Purpose: This study compares the diagnostic performance of 18F-FACBC PET with conventional CT and assesses its role in clinical management of patients with biochemically recurrent (BCR) prostate cancer (PCa).

Materials and Methods: Institutional review board approval was obtained. 77 patients with BCR PCa who underwent 18F-FACBC PET/CT for assessment of the site of recurrence were enrolled. PCa recurrence detection rate was compared between PET and same-day CT. Correlation of 18F-FACBC uptake was made to pre-scan PSA, original tumor Gleason score (GS), tumor resection margin, and type of prior treatment. Change in the management plan based on 18F-FACBC PET/CT findings was assessed.

Results: 18F-FACBC uptake was positive in 46/77 (60%), negative in 25/77 (32%), and equivocal in 6/77 (8%) patients. Abnormal uptake was noted in the prostate/bed in 23/46 (50%), extraprostatic pelvic soft tissues in 28/46 (61%) and extra-pelvic sites in 20/46 (43%) patients. Positive detection rate was higher in 18F-FACBC PET compared to the same-day CT (60% vs. 49% respectively). Overall management decision changed in 40/62 (65%) patients (pending management in 15/77 patients). Files of radiotherapy was changed in 9/30 (30%) patients. 18F-FACBC PET/CT detection rate increased with higher PSA levels (mean \pm SD: 3.58 ± 4.43 ; range 0.15–20.92 ng/ml), shorter PSA-DT, higher GS and positive resection margin ($p < 0.05$). Lesion detection rate was significantly higher in patients who received radiotherapy (9/11: 81%) compared to patients who underwent prostatectomy (11/26: 42%) or combination of \geq two treatment modalities (24/39:61%), $p < 0.05$.

Conclusions: 18F-FACBC PET/CT performs superior to CT for detection of site of PCa recurrence and significantly changes the clinical management of the patients with BCR PCa.

11:52 AM**IMAGING OF PSMA-TARGETED RADIOTRACERS FOR THE DETECTION OF PROSTATE CANCER BIOCHEMICAL RECURRENCE AFTER DEFINITIVE THERAPY: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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Purpose: To report the results stratified by PSA levels of a systematic review and meta-analysis for detection of biochemical recurrence (BCR) for prostate cancer using PSMA-targeted radiotracers.

Materials and Methods: Following the Preferred Reporting Items for Systematic reviews and Meta-Analysis Diagnostic Test Accuracy (PRISMA-DTA) guidelines, a systematic review from 2012 to July 2018 was performed. QUADS-2 was used to assess risk of bias and applicability concerns. The reference standard was pathology, follow-up imaging, or PSA decline after salvage treatment. We calculated the pooled estimates and 95% confidence intervals around the prevalence of a positive exam in the study population using a random-effects model.

Results: 5113 patients from 43 studies were included. 15 (34.8%) studies were prospective. 3 (6.9%) were multi-institutional. 35/45 (77.8%) of the studies evaluated 68-Ga PSMA-11 PET/CT. Pooled detection rate was 70.2% (95% CI 65.0–75.4%) for the entire cohort. For PSA < 0.5 ng/ml, 0.5–0.9 ng/ml, 1–1.9 ng/ml and \geq 2 ng/ml, the

pooled detection rates were 44.9% (36.0–53.9%), 61.3% (95% CI 52.3–70.3%), 78.2% (95% CI 70.8–85.6%), and 93.9% (95% CI 92.0–95.8%). A reference standard was confirmed positive in 684/715 (95.7%) of the patients in 23/45 (51.1%) of the studies. There was significant study heterogeneity and publication bias in the overall cohort.

Conclusions: PSMA-targeted radiotracers are likely effective for the detection of BCR at very low PSA levels.

12:08 PM

LUMINAL WATER IMAGING OF PROSTATE CANCER: QUANTITATIVE COMPARISON WITH DWI FOR CHARACTERIZATION OF CANCER AGGRESSIVENESS

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Purpose: To compare the diagnostic performance of a novel T₂ mapping technique [luminal water imaging (LWI)] to DWI for assessment of prostate cancer (PCa) aggressiveness.

Materials and Methods: Eleven PCa patients scheduled to undergo prostatectomy were recruited prospectively (mean age 60 years, range 46–70 years). LWI T₂ mapping was acquired using turbo spin echo sequence with TR/TE 3680/30–900. LWI parameters (geometric mean of the short, long components and entire distribution T_{2 short}, T_{2 long}, gmT₂ and luminal water fraction LWF) were quantified in index tumors and PZ tissue. ADC values in tumors and PZ were quantified from b50 and b1000 DWI data. Gleason score (GS) and Grade Groups (GG) were retrieved from prostatectomy reports. Wilcoxon signed-rank tests, Mann–Whitney *U* tests and ROC analysis were used to assess differences between MRI parameters in tumors and PZ and between GS/GG scores.

Results: Mean lesion size was 1.9 cm (range 1.3–3.7 cm). All LWI parameters and ADC were significantly different between PZ and PCa (*p* < 0.001 for all parameters). GS distribution of the index lesions was as follows: GS7, *n* = 10; GS9, *n* = 1. GG distribution was: GG2, *n* = 7; GG3, *n* = 3; GG5, *n* = 1. LWI parameters T_{2 long} and LWF showed a significant difference between GG2 and GG3 cancers (*p* = 0.033 for both parameters, AUC = 0.952), while ADC did not (*p* = 0.383, AUC = 0.714).

Conclusions: Our preliminary results suggest additional value of LWI to ADC for characterization of prostate cancer. These findings need to be validated in a larger patient cohort that will be recruited in our ongoing study.

12:16 PM

IMPACT OF PROPOSED CHANGES TO PI-RADSV2 ON DIAGNOSTIC PERFORMANCE OF MRI: PATHOLOGIC CORRELATION WITH IN-BORE MRI-GUIDED PROSTATE BIOPSIES

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Purpose: We evaluated the diagnostic performance of PI-RADSV2 for prostatic lesions that underwent in-bore MRI-guided biopsy. We then studied how this performance would change under proposed PI-RADSV2 modifications.

Materials and Methods: Two radiologists retrospectively reviewed diagnostic prostate MRIs at a tertiary care academic institution for lesions that underwent in-bore MRI-guided prostate biopsies. The reviewers tabulated the following: indication, lesion location, size, margin, T2 signal, T2 PI-RADS score, DWI signal, ADC signal, ROI ADC value, DWI PI-RADS score, overall PI-RADSV2 score, revised PI-RADS score using proposed upgrades (doi.org/https://doi.org/10.1148/radiol.2016161124), clinical suspicion of prostate cancer, and extraprostatic extension, early contrast enhancement, washout, and/or prostatitis. Inter-rater agreement was assessed with Cohen's kappa.

Results: Of a total of 104 lesions, 42 (40%) were Gleason 6 and 22 (21%) Gleason 7+. Inter-rater agreement was 0.92 ± 0.08 for location, 0.29 ± 0.14 for PI-RADS, and 0.30 ± 0.16 for PI-RADS with proposed upgrades. The percentage of low (Gleason 6) vs high-grade (Gleason 7+) disease from PI-RADSV2 3, 4, and 5 lesions was 11%/5%, 14%/22%, and 42%/33% for reader 1 and 10%/15%, 16%/29%, and 40%/24% for reader 2. The sensitivity/accuracy of detection of Gleason 7+ disease from PI-RADS 4 or 5 was 0.95/0.40 for reader 1 and 0.86/0.48 for reader 2. With proposed revisions to PI-RADSV2, the sensitivity/accuracy changed to 1.0/0.26 and 1.0/0.39.

Conclusions: Fair inter-rater agreement was achieved using PI-RADSV2 with excellent sensitivity, but moderate accuracy. With proposed revisions, sensitivity is improved at the expense of accuracy. Understanding PI-RADS performance and proposed changes is critical for the management of higher-risk patients being considered for specialized biopsies.

IMPROVING CLINICAL PRACTICE SCIENTIFIC PAPER SESSION

10:00 AM

OUTCOMES OF RADIOLOGY MEDICAL MALPRACTICE LAWSUITS IN THE USA, WITH A SPECIAL FOCUS ON CASES INVOLVING THE ABDOMEN AND PELVIS, 2008–PRESENT

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Purpose: Malpractice is a significant concern to radiologists; 50% will be sued by age 60. A survey reports the threat of malpractice influences the thinking or actions of 50% of radiologists almost all the time or always. This study analyzes malpractice suits against radiologists in the US for the past 10 years, to characterize the volume, resolution, payout, modality, and pathology implicated, with a special focus on claims involving the abdomen/pelvis.

Materials and Methods: A search for radiology malpractice cases from 2008–April 2018 in all states, as well as DC and Federal cases, was performed using LexisAdvance, a subscription database, yielding 2501 results. Cases where a radiologist was not the defendant were deleted, yielding 1036 relevant cases. Each case was analyzed to determine the resolution, type of error (diagnostic, procedural

complication, or communication), imaging modality, if the case involved the GI/GU system, and the average plaintiff award.

Results: 31% of cases settled (average payment \$1,304,419). 41% of cases went to trial, with 23% resulting in a plaintiff verdict (average award \$8,393,274). 28% of cases had no known resolution. 82% of cases were due to diagnostic error, 6% communication failure, 10% procedural complications, and 1% involved multiple errors. Mammography was the most commonly implicated modality (26%), followed by CT (24%). 15% of cases involved the GI system, 6% GU, and 2% other abdominal/pelvic structures. Commonly missed pathologies in the abdomen/pelvis included renal cell carcinoma and bowel ischemia.

Conclusions: Increased awareness of the volume and outcomes of malpractice cases can help radiologists cope with the uncertainty that accompanies a suit, and understand the most common errors that result in litigation, hopefully avoiding these pitfalls.

10:16 AM

SOCIETY OF ABDOMINAL RADIOLOGY GI BLEEDING DISEASE FOCUS PANEL CONSENSUS RECOMMENDATIONS FOR CTA TECHNICAL PARAMETERS IN THE EVALUATION OF ACUTE GASTROINTESTINAL BLEEDING

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Purpose: To develop expert consensus recommendations for CTA technical parameters in the evaluation of acute gastrointestinal bleeding (GIB).

Materials and Methods: A panel of sixteen radiologists with expertise in the imaging of GI bleeding was surveyed to obtain CTA technical parameters used at their site for evaluating acute GIB. Parameters from 15 prior published investigations were also recorded. Results were summarized and reviewed by the panel. Delphi method (2 rounds) was performed using a 20 question electronic survey of the panel members to obtain consensus agreement of at least 80%.

Results: Consensus was obtained for 13 of the 20 questions including: no use of oral contrast, high concentration iodine injected at a flow rate of 4–5 ml/s, the performance of low-dose unenhanced images followed by two post-contrast phases, the use of bolus tracking techniques to time arterial phase imaging, scan delays consisting of late arterial phase with a second delayed phase, image reconstruction of 1-3 mm in axial thickness with the use of multiplanar reconstructions and CTA billing codes. Dual energy options which reached consensus included the use of virtual non-contrast images, low-kV monoenergetic images and iodine maps. Dual energy offers the ability to lower the amount of contrast which should be chart-based and determined by weight and kV.

Conclusions: There is wide variability in the technique used for CTA in the evaluation of acute GIB. Consensus agreement was reached by a panel of experts for the majority of parameters. These recommendations should lead to more standardized performance of the test and the ability to allow more accurate comparisons between studies. Recommendations will need further adjustment as more scientific data becomes available.

10:32 AM

THE LONDON SCORE FOR SEVERITY OF ACTIVE SMALL BOWEL INFLAMMATION AT MR ENTEROGRAPHY (MRE): CAN WE EXTEND THIS MEASURE TO CT ENTEROGRAPHY (CTE)?

Eric Ehman, Shannon P. Sheedy, John Barlow, Yong S. Lee, Jeff Fidler, David Bruining, Cynthia H. McCollough, David Holmes, Rickey E. Carter, Joel Fletcher

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Purpose: To develop a reproducible method to predict the London Score of small bowel inflammation from CT enterography (CTE) images.

Materials and Methods: 43 patients with biopsy-proved Crohn's disease underwent paired MRE and CTE exams within 30 days. One GI radiologist marked MRE images to calculate the MRE London Score for the distal 10 cm of the terminal ileum (TI). Another marked CTE images, placing calipers across the TI bowel wall, and a normal-appearing ileal loop. Descriptive measures of wall thickness and attenuation, in addition to dichotomous decisions (e.g., mural stratification present/absent) were used to create a Random Forest Model for CTE London Score. Subsequently, two other GI radiologists marked the same CTE images, and responded to the same dichotomous questions. Accuracy of the fitted model for CTE London Score was assessed by comparison with MRE London Score using R-square (R²). Observer agreement was assessed by intraclass correlation coefficients (ICC).

Results: The ICC for comparison of the MRE London score to the proposed CTE London score using the Random Forest model derived from CTE was R² = 0.96 ($p < 0.0001$). The ICC for the two validation readers interpreting the same CTE datasets was 0.70 and 0.79, respectively ($p < 0.0001$), using the developed Random Forest model. Interobserver agreement between the original CTE interpretation used to create the model and the validation readers was also high (ICC = 0.75 and 0.83, respectively, $p < 0.0001$).

Conclusions: A random forest model can be used to create reproducible CTE London Scores that are highly correlated with MRE London scores, permitting comparison of inflammation severity over time in patients regardless of the imaging modality (CTE, MRE).

10:40 AM

ACCURACY OF AN AUTOMATED CONVOLUTIONAL NEURAL NETWORK LIVER SEGMENTATION-BASED METHOD TO ESTIMATE WHOLE-LIVER HEPATIC PROTON-DENSITY FAT FRACTION (PDFF)

Kang Wang¹, Hashem Almahmoud¹, Adrija Mamidipalli¹, Timoteo Delgado¹, Rohit Loomba¹, Veeral Ajmera¹, Brent A. Neuschwander-Tetri², James Tonascia⁴, Joel E. Lavine³, Michael Middleton¹, Albert Hsiao¹, Claude Sirlin¹

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Purpose: To evaluate the accuracy of a convolutional neural network (CNN)-based liver segmentation method to estimate whole-liver hepatic proton-density fat fraction (PDFF) using a manual region of interest (ROI)-based method as reference, in a population of patients with biopsy-proven non-alcoholic steatohepatitis (NASH).

Materials and Methods: We obtained 113 baseline MRI PDFF exams of adults with biopsy-proven NASH enrolled in the multicenter, multi-scanner FLINT clinical trial. The CNN-based method automatically segments the liver from multi-echo spoiled-gradient-recalled (SPGR) images and estimates mean hepatic PDFF across the whole liver using a bi-Gaussian statistical model. Reference mean whole-liver PDFF values were obtained by manually placing nine ROIs in the liver, one for each Couinaud segment (manual ROI-based method). Agreement and systematic disagreement between CNN-based and manual PDFF values were evaluated using Bland–Altman and intraclass correlation analyses.

Results: Mean whole-liver CNN-based PDFF was 18.1% (range 4.1% to 45%) and mean manual reference ROI-based PDFF was 18.2% (range 3.7% to 47%). In Bland–Altman analyses, the CNN-based PDFF did not significantly underestimate manual ROI-based method (paired t test difference = 0.07%, $p = 0.95$); 95% limits of agreement values were (− 1.33%, 1.19%). The intraclass correlation coefficient (ICC) between the two methods was 0.997 (95% CI, 0.996, 0.998).

Conclusions: An automated CNN-based algorithm accurately estimates whole-liver PDFF in a well-curated, multicenter, multi-scanner study, justifying further investigation into using this technology to more efficiently evaluate hepatic quantitative imaging biomarkers.

10:48 AM

AUTOMATED LIVER SEGMENTATION-BASED ESTIMATION OF HEPATIC PROTON-DENSITY FAT FRACTION (PDFF) MAY IMPROVE INTRA- AND INTER-EXAM REPEATABILITY

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Purpose: To compare intra- and inter-exam repeatability of whole-liver hepatic proton-density fat fraction (PDFF) using a convolutional neural network (CNN)-based liver segmentation method versus using a manual region of interest (ROI)-based method.

Materials and Methods: 27 subjects underwent three same-day MR examinations. In each examination, a confounder-corrected, chemical shift-encoded MR sequence with magnitude reconstruction was obtained three times. For each MRI acquisition, whole-liver hepatic PDFF was estimated using both the CNN-based method and a manual ROI-based method in which three 2-cm circular ROIs were placed manually in the liver. For each method, intra- and inter-examination repeatability was assessed by computing standard deviations (SDs) and intraclass correlation coefficients (ICCs). Intra- and inter-exam SDs (ICCs) were compared pairwise across methods using paired t tests (bootstrap-based test).

Results: Mean intra-examination SD for the CNN-based method (0.11%; 95% CI 0.08%, 0.14%) was lower ($p < 0.0001$) than for manual ROI-based method (0.25%; 0.20%, 0.30%). Mean inter-examination SD for the CNN-based method (0.15%; 0.10%, 0.20%) was

lower ($p = 0.003$) than for the manual ROI-based method (0.42%; 0.27%, 0.57%). Mean intra-/inter-examination ICCs for both methods were greater than 0.99 and there is no difference between methods.

Conclusions: Automated CNN-based estimation of hepatic PDFF may improve precision compared to conventional manual ROI-based estimation. Further investigation is warranted using this technology to more efficiently evaluate hepatic quantitative imaging biomarkers.

10:56 AM

MULTICENTER, MULTI-VENDOR REPRODUCIBILITY OF CONFOUNDER-CORRECTED R2* MAPPING FOR LIVER IRON QUANTIFICATION AT 1.5T AND 3T: INTERIM RESULTS

Diego Hernando¹, Ruiyang Zhao¹, Valentina Taviani⁷, Mounes Aliyari Ghasabeh⁴, Li Pan⁵, Qing Yuan², Stefan Ruschke³, Dimitrios Karampinos³, Xiaodong Zhong⁵, Ryan Mattison¹, Ihab R. Kamel⁴, Ivan Pedrosa², Shreyas Vasanawala⁶, Takeshi Yokoo², Scott B. Reeder¹

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Purpose: R2* is a promising biomarker of liver iron concentration (LIC), with application in the assessment of iron overload. Although R2* measurements may be affected by multiple confounding factors, confounder-corrected R2* mapping has been shown to be highly promising in single-center studies. However, the multicenter reproducibility of confounder-corrected R2* for liver iron quantification remains unknown. To address this unmet need, we are near completion of an NIH-funded four-center, three-vendor (GE Healthcare, Philips, Siemens) study performed at 1.5T and 3T to determine the reproducibility of confounder-corrected liver R2* as a biomarker of liver iron overload.

Materials and Methods: Patients with known or suspected iron overload are recruited at each site with IRB approval and informed written consent. Liver R2* mapping data are acquired at 1.5T and 3T on each patient at each site, and a common confounder-corrected R2* mapping algorithm is applied. The FDA-approved FerriScan method (Resonance Health, Claremont, Australia) is serving as the reference standard at each site.

Results: In our interim results based on 119/200 patients recruited, excellent correlation of R2* with Ferriscan-LIC was observed at all sites (overall 1.5T $r^2 = 0.90$, slope = 2.70×10^{-2} mg Fe/g dry/s⁻¹, intercept = − 0.12 mg Fe/g dry; 3T $r^2 = 0.91$, slope = 1.46×10^{-2} mg Fe/g dry/s⁻¹, intercept = − 0.19 mg Fe/g dry). Additionally, high reproducibility was observed in the R2*-LIC calibration across sites, with only a significant effect for slope at one of the sites. Finally, excellent correlation of R2* across field strength (1.5T vs. 3T) was observed for all sites (overall $r^2 = 0.99$).

Conclusions: Excellent correlation and reproducibility of R2* mapping for liver iron quantification are observed across sites, vendors and field strengths.

11:04 AM**UTILITY OF CONTRAST-ENHANCED ULTRASOUND IN FIRST YEAR OF IMPLEMENTATION**

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Purpose: To determine the accuracy, adequacy, and clinical impact of contrast-enhanced ultrasound (CEUS) in evaluating indeterminate findings detected on prior imaging.

Materials and Methods: A total of 95 CEUS studies performed since the implementation of CEUS at our institution from January 2017 until September 2018 were retrospectively reviewed. Forty one renal, 45 hepatic, and 9 examinations of other organ systems comprised the study population. Assessment of diagnostic accuracy was based upon histology and imaging follow-up. Change in management and reasons for nondiagnostic/indeterminate studies were reviewed.

Results: A total of 41 renal CEUS studies were performed for evaluation of indeterminate renal lesions on prior imaging studies and 95.1% (39/41) were successfully classified. Nine patients underwent nephrectomy for RCC with 100% accuracy. Forty-five hepatic lesions were evaluated for indeterminate liver lesions and 42 were adequately classified. Four patients underwent surgery with 100% accuracy. Other organ systems included the cervix, bowel, urinary bladder, spleen, and the axilla. Results of CEUS changed management in a minimum of 6 cases by avoiding biopsy or intervention and changing the surgical approach. Four nondiagnostic studies resulted from: small size of a renal lesion and poor visualization on B-mode, lack of ultrasound contrast on delayed phase of a liver nodule, inadequate enhancement of a deep liver lesion, and microbubble destruction due to resistance during injection.

Conclusions: CEUS has high-diagnostic accuracy, versatility, and clinical impact in first year of implementation.

11:12 AM**SCREENING FOR KIDNEY ALLOGRAFT REJECTION: ULTRASOUND-BASED PROBABILITY STRATIFICATION**

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Purpose: To develop a mathematical model to screen for kidney graft rejection based on sonographic features, including a newly proposed feature: the presence of urothelial thickening.

Materials and Methods: Patients with renal transplant ultrasounds performed within 14 days of a kidney graft biopsy performed in the setting of renal dysfunction, between January 2005 and August 2018, were included. A total of 115 patients were identified (average age: 53 years; 35 female). Recorded ultrasound features were presence of urothelial thickening, perfusion, echogenicity, renal artery velocity, and Intraparenchymal Resistive Index. Biopsy results were recorded as rejection vs other etiology (ATN, drug toxicity, infection, no diagnosis). A multi-variable regression full model that included

sonographic features was used to evaluate for the presence or absence of rejection.

Results: There were 25 cases of rejection (43 ATN, 14 drug toxicity, 3 infection, 30 no diagnosis). The AUC for the full model in predicting rejection was 0.86. Of the variables, only urothelial thickening proved to be a statistically significant predictor for the presence of rejection ($p < 0.01$). Graft perfusion, echogenicity, renal artery velocity, and intraparenchymal resistance were not significantly additive to the model ($p = 0.46, 0.54, 0.48, 0.99$, respectively). The presence of urothelial thickening alone had a sensitivity of 92%, specificity 64%, PPV 42%, and NPV 97%.

Conclusions: Urothelial thickening is the most important sonographic feature in assessing for renal graft rejection. Classically described features of perfusion, echogenicity, and Resistive Index play little if any role in assessing for rejection. Given the high NPV, the absence of urothelial thickening may obviate the need for graft biopsy in selected patients.

11:20 AM**IMPACT OF PATIENT PREPARATION ON PROSTATE MRI QUALITY**

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Purpose: To measure the impact of a set of instructions for patient preparation for prostate MRI on image quality and on reader's confidence in interpretation.

Materials and Methods: This retrospective study included treatment-naïve men who underwent a prostate MRI. Patients were instructed to perform an enema before the exam with at least 6 h of dietary and caffeine restriction. Patients answered a survey related to preparation adherence including an inconvenience score (1–5) for each instruction. A reader independently reviewed the images blinded to survey results and reported image quality metrics on a 5-point scale. A Wilcoxon rank sum test was used to compare each image quality metric.

Results: Of the 249 surveys collected, 80 patients who met inclusion criteria were divided into three groups. Compared with patients who did not use the enema, adherent patients had a significantly smaller amount of gas and stool in the rectum ($p < 0.001$), lower levels of DWI distortion ($p 0.031$) and higher confidence in exam interpretation ($p 0.045$). Comparatively, patients who used the enema but did not comply with diet restriction had a higher degree of rectal peristalsis ($p 0.036$) but no significant difference in the confidence of interpretation. The average inconvenience score for an enema and dietary restriction were 2.3 and 1.2, respectively.

Conclusions: In this study, an enema resulted in a significant decrease in the amount of rectal stool and gas, lower DWI distortion and improved confidence in exam interpretation. Dietary restrictions resulted in lower rectal peristalsis but without a significant impact on image quality or confidence of interpretation. Quality imaging is paramount in prostate imaging and an enema prior to MRI, though slightly inconvenient, may optimize image quality and raise confidence in interpretation.

11:28 AM**VALIDATION OF PI-RADS v2 FOR DETECTION OF PROSTATE CANCER USING US/MRI FUSION-GUIDED PROSTATE BIOPSY AS REFERENCE STANDARD**

Jinxing Yu, Jaruwit Rergyamdee, Ann S Fulcher, Sarah Winks, Mary Ann Turner, Alberto Cristobal, Patrick Reddy

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Purpose: To evaluate diagnostic performance of prostate multiparametric MRI (mpMRI) using PI-RADS v2 in detection of prostate cancer (PCa).

Materials and Methods: Between 7/1/2015 to 12/31/2017, 685 patients underwent prostate mpMRI and then US/MRI fusion target biopsies. To be considered suitable candidates for the study, patients had to have at least one cancer-suspicious region (CSR) at prostate mpMRI and no prior history of PCa treatment. All CSRs at MRI were assigned PI-RADS scores based on PI-RADS v2 when studies were interpreted. All patients' pathology reports from target biopsies were recorded in detail as well as patients' age, PSA, PSA density and prostate volume. Statistical analysis applied to the data collected.

Results: US/MRI fusion-guided prostate biopsies of 945 lesions in 685 patients were performed and revealed 725 PCa (77% tumor detection rate). In PI-RADS 5 ($n = 315$), 4 ($n = 285$) and 3 ($n = 345$) lesions, the detection rates of PCa was 95%, 88% and 51%, respectively. In the Mann–Whitney U test, the mean age and PSA between patients with PCa ($n = 725$) and without PCa ($n = 220$) were not statistically significant except for PSA density (median 0.26 vs. 0.14 ng/ml/cc, $p < 0.001$).

Conclusions: Tumor detection rate of 77% amongst lesions deemed suspicious for PCa at mpMRI using PI-RADS v2 was demonstrated. Among them, 95% and 88% of PI-RADS 5 and 4 lesions were proven to be PCa. Our results support PI-RADS v2 as a reliable and replicable reporting system for detection of PCa.

11:36 AM**PSA DENSITY AND ADC VALUES IMPROVE THE DIAGNOSTIC ACCURACY OF PI-RADS v2**

Antonio C. Westphalen, Farhad K. Fazel, Hao Nguyen, Miguel Cabarrus, Katryana Hanley-Knutson, Katsuto Shinohara, Peter R. Carroll

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Purpose: To determine if PSAD and ADC values improve the accuracy of PI-RADS v2 and identify patients likely to have high-grade cancer in areas without mpMRI visible lesions.

Materials and Methods: IRB-approved, HIPAA complaint study. Signed consent was waived. Single reference-center, cross-sectional, retrospective study of consecutive men with suspected or known low to intermediate-risk prostate cancer who underwent 3T mpMRI and TRUS-MRI fusion biopsy from 07/15/2014 to 02/17/2018. Cluster-corrected logistic regression analyses were utilized to predict high-grade prostate cancer (Gleason score $\geq 3 + 4$) at targeted mpMRI lesions and on systematic biopsy.

Results: 538 men (median age = 66 years, median PSA = 7.0 ng/ml) with 780 mpMRI lesions were included. High-grade disease was diagnosed 371 men. PI-RADS v2 scores of 3, 4, and 5 were high-

grade cancer in 8.0% (16/201), 22.8% (90/395), and 59.2% (109/184). ADC values, PSAD, and PI-RADS v2 scores were independent predictors of high-grade cancer in targeted lesions (OR 2.25–8.78; p values < 0.05 ; AUROC 0.84, 95% CI 0.81–0.87). Increases in PSAD were also associated with upgrade on systematic biopsy (OR 2.39–2.48; p values < 0.05 ; AUROC 0.69, 95% CI 0.64–0.73). Study limitations include its retrospective single-institution design and use of biopsy rather than prostatectomy specimens of standard of reference.

Conclusions: ADC values and PSAD improve characterization of PI-RADS v2 score 4 or 5 lesions. Upgraded on systematic biopsy is slightly more likely with PSAD ≥ 0.15 and multiple small PI-RADS v2 score 3 or 4 lesions. The results of this study may help to develop a new version of PI-RADS, enhance the characterization of lesions visible on mpMRI, and improve the identification of men with high-grade prostate cancer.

11:44 AM**POSITIVE PERFUSION: HOW OFTEN DOES IT AFFECT THE PI-RADS SCORE IN CLINICAL PRACTICE?**

Jason Birnbaum, Mariya Kobi, Devaraju Kanmaniraja, Judy Yee, Victoria Chernyak

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Purpose: Biparametric prostate MRI (bpMRI) omits dynamic contrast-enhanced (DCE) sequences, allowing for reduced scan time and costs. Prostate Imaging Reporting and Data System (PI-RADS, PR) version 2 (v2) uses DCE to upgrade PI-RADS score from 3 to 4 in peripheral zone (PZ) lesions with a score of 3 on diffusion-weighted imaging (DWI). The goal of this study was to assess the frequency with which positive perfusion upgrades the PI-RADS score in clinical practice.

Materials and Methods: Reports of prostate MRI performed 1/2017–8/2018 were reviewed, retrospectively. For each reported PI-RADS 3, 4 or 5 lesion, we recorded the lesion size, location (PZ or TZ) and the scores on T2-weighted (T2w), DWI and DCE. The PI-RADS score was assigned based on the reported imaging features using PI-RADS v2. The percent of the lesions with an upgraded final PI-RADS score based on DCE was tabulated.

Results: There were 558 patients (mean age 64 years, SD 8) with 858 lesions. Of 858 lesions, 570 (66%) were in PZ. 54% (308/570) of PZ lesions had DWI score of 3; of these, 27% (82/308) had positive perfusion. Perfusion upgraded the PR score from 3 to 4 in 10% (82/858) of all lesions. In 56 (10%) of 558 patients, the upgraded lesion was the lesion with the highest PI-RADS score.

Conclusions: Omitting DCE would result in downgrading from PR4 to PR3 in 10% of all reported prostate lesions. In 10% of patients, the downgraded lesion was the lesion with the highest PI-RADS score.

11:52 AM**PROSTATE CANCER DETECTION RATE BY 3-TESLA IN-BORE MR-GUIDED BIOPSY: HOW DOES IT IMPACT THE CLINICAL PERCEPTION?**

Melina Hosseiny, Ely Felker, Sohrab Afshari, Afshin Azadikhah, Danielle Ponzini, Amir Mohammadian Bajgiran, Steven S. Raman

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Purpose: To assess the efficacy of 3 Tesla in-bore trans-rectal magnetic resonance-guided biopsy (3T-MRGB) for prostate cancer (PCa) detection based on PI-RADSv2 in patients with either suspected Pca or under-active surveillance.

Materials and Methods: This IRB-approved, retrospective study, assessed data of 325 consecutive patients who underwent MRGB (February 2012–July 2018). After excluding twenty-six patients, the final study cohort comprised 299 patients (mean age 68 years) divided into two subcohorts: those with no prior prostate cancer (NPCa) ($n = 182$) and those under-active surveillance (AS) ($n = 117$). Cancer detection rate, comparison with prior template trans-rectal ultrasound (TRUS)-guided biopsy and the percentage of clinically significant disease (CSD, defined as $GS \geq 7$) were evaluated. The detection rate was also correlated with preprocedural PIRADSv2 score.

Results: Mean target sample per gland was 1.3. MRGB-detected PCa in 62.2% (186/299) of patients of whom 73.1% (136/186) had CSD. No significant difference was seen in cancer detection rate between transitional (94/158) and peripheral zone (131/236) lesions ($p > 0.5$). 3T-MRGB-detected PCa in 55.5% (101/158) of patients in the NPCa subcohort, of whom 31.7% (32/101) had prior negative TRUS-guided biopsy. In AS subcohort, 3T-MRGB upgraded GS in 41% (48/117) of patients compared to GS from TRUS-guided biopsy. Overall, 3T-MRGB altered clinical management in 26.7% (80/299) of patients. The overall and CSD detection rates for PIRADSv2 grades of 3, 4 and 5 were 26/78 (33.3%), 64/92 (69.9%), and 73/75 (97.3%); and 15/78 (19.2%), 46/92 (50%) and 59/75 (78.7%), respectively. The rate of urosepsis was 0.6% (2 cases).

Conclusions: 3T MRGB showed a high rate of overall PCa and CSD detection in patients with suspected PCa and those undergoing AS, altering clinical perception in 26.7% of cases.

12:08 PM

ISOLATED RIGHT-SIDED SCROTAL VARICOCELE: WHAT IS THE PREVALENCE OF INTRA-ABDOMINAL MALIGNANCY CAUSING VASCULAR COMPRESSION?

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Purpose: To determine the prevalence of intra-abdominal malignancy as the etiology of isolated right-sided scrotal varicoceles.

Materials and Methods: A retrospective review of adults with isolated right-sided varicoceles diagnosed by ultrasound between 08/2010 and 05/2018 was performed. The reference standard for absence of intra-abdominal malignancy as the source of the varicocele was either (1) an abdominopelvic CT or MRI within or after 3 months of the ultrasound showing no obstructing mass or (2) no evidence of malignancy at clinical follow-up 2 or more years after the ultrasound.

Results: Of 121 isolated right-sided varicoceles, either reference standard was available in 88 patients (45 with correlative imaging and 43 with two-year clinical follow-up). Mean patient age was 51.4 years. No patients had intra-abdominal malignancy as the source of isolated right-sided varicocele (0%, 95% CI 0, 3.3%). While two patients had intra-abdominal malignancy (one case of hepatocellular

carcinoma and one of metastatic germ cell tumor), neither malignancy had a plausible association with the isolated right-sided varicocele, i.e. involvement of the IVC, renal, or gonadal vein.

Conclusions: The prevalence of intra-abdominal malignancy causing vascular compression as the source of isolated right-sided varicoceles is very low, with no cases in our study. Follow-up imaging of the abdomen and pelvis may not be indicated when isolated right-sided varicoceles are found on scrotal ultrasound.

POWER SCIENCE PAPER SESSION

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THERMAL ABLATION OF T1a RCC: OUTCOMES INFORM SURVEILLANCE IMAGING PROTOCOLS

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Purpose: Surveillance imaging after thermal ablation (TA) of renal cell carcinoma (RCC) varies across institutions. The purpose of this study is to evaluate timing of local tumor progression (LTP) after percutaneous TA of T1a RCC to inform surveillance protocols.

Materials and Methods: Consecutive patients with histologically confirmed clinical stage T1a (≤ 4.0 cm) RCC treated with microwave (MW) or cryoablation from 2001 to 2017 were included. Patients with RCC syndromes were excluded. Contrast-enhanced CT (CECT) was performed immediately after TA to confirm treatment success. In the MW cohort, immediate retreatment was performed if residual tumor was identified. Then, surveillance imaging with CECT or MRI was performed at target intervals of 6, 12, 18, and 24 months and annually thereafter. LTP was defined according to established criteria.

Results: Three hundred patients (197 M/103 W; median age 68 ± 14) were treated with TA including 184 MW (61.5%) and 116 cryoablation (38.5%). Zero patients treated with MW and 6 patients (5.2%) treated with cryoablation had residual tumor at 6-month follow-up. Median imaging follow-up after MW and cryoablation was 20 months (IQR 8–39) and 43 months (IQR 22–72), respectively. LTP occurred in 8 (4.4%) and 9 (7.8%) patients after MW and cryoablation, respectively. Median time to recurrence for MW was 15 months (IQR 10–31); the earliest and last LTP were discovered at 9 and 49 months, respectively. Median time to recurrence for cryoablation was 33 months (IQR 20–68); the earliest and last LTP were discovered at 15 and 85 months, respectively.

Conclusions: CECT performed at the time of MW ablation reduces the incidence of residual disease and may delay the need for initial surveillance imaging until 6–9 months. To capture all LTP, surveillance imaging should continue beyond 4 years.

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ACR US LI-RADS: MULTICENTER ASSESSMENT OF CLINICAL PERFORMANCE AT ONE YEAR

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Purpose: To evaluate the clinical performance of the American College of Radiology's Ultrasound Liver Reporting and Data System (US LI-RADS) Version 2017 for detecting hepatocellular carcinoma (HCC) in patients at high risk for HCC.

Materials and Methods: In this retrospective, multicenter study, 2050 patients at high risk for HCC (1078 men and 972 women; mean age 57.7; range 18–96 years) at 5 sites had undergone screening liver ultrasound from January to September 2017 and US LI-RADS observation categories and visualization scores were assigned on a clinical basis. Ultrasound reports and patient records were retrospectively reviewed and any follow-up imaging studies and/or pathologic reports recorded. Statistical analysis was performed.

Results: The most common indications for HCC screening were cirrhosis ($n = 1054$; 51.4%), non-cirrhotic HBV ($n = 555$; 27.1%), and non-cirrhotic HCV ($n = 234$; 11.4%). US LI-RADS observation categories assigned were: US-1 (Negative) in 90.4% ($n = 1854$); US-2 (Subthreshold, short-term follow-up recommended) in 4.6% ($n = 95$); and US-3 (Positive) in 4.9% ($n = 101$). Visualization scores were: A (No or minimal limitations) in 76.8% ($n = 1575$); B (Moderate limitations) in 18.9% ($n = 388$); and C (Severe limitations) in 4.2% ($n = 87$). Confirmatory tests including multiphase contrast-enhanced CT or MRI ($n = 212$) or histopathology ($n = 9$) were available for 221 patients. The sensitivity of US LI-RADS in this subset of patients was 77.5%, specificity 58.9%, PPV 40.2%, and NPV 88.1%.

Conclusions: Approximately, 90% of US LI-RADS screening exams were negative, 5% subthreshold, and 5% positive. Visualization scores were diagnostically acceptable in the vast majority (> 95%) of exams. US LI-RADS exhibited moderately high sensitivity and NPV, key characteristics of a screening test.

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PROSTATE IMAGING AND DATA REPORTING SYSTEM VERSION 2 (PI-RADSV2) ASSESSMENT CATEGORY 3 OBSERVATIONS: CAN WE IMPROVE STRATIFICATION OF INTERMEDIATE OBSERVATIONS TO BETTER GUIDE MANAGEMENT?

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Purpose: PI-RADSV2 category-3 observations are indeterminate for clinically significant (Gleason score ≥ 7) cancer with wide variation in cancer detection rates reported at targeted biopsy. This study evaluates features which may improve stratification of category-3 observations.

Materials and Methods: With IRB approval, 118 peripheral and 132 transition zone (PZ/TZ) category-3 observations reported on 3-Tesla-

mpMRI were retrieved from our PACS between 2012 and 2018. Patient age, PSA, prostate volume, PSA density and clinical stage was recorded. A blinded expert Radiologist reviewed all observations and re-assigned PI-RADSV2 categories. Size, ADC and ADC.ratio (ADC.tumor/ADC.normal peripheral zone) were measured for each observation. Number of targeted biopsies and histological diagnoses were compared using multi-variable analysis and logistic regression. Accuracy was assessed with ROC.

Results: Mean observation size was 12 ± 6 mm (range 5–30). 61% (72/119) PZ and (50% [66/132] TZ observations underwent targeted biopsy ($p = 0.216$) with 19.4% [14/72] PZ and 4.5% [3/66] TZ subsequent significant cancers diagnosed. Smaller prostate volumes ($p = 0.031$), higher PSA density (0.042) and clinical stage ($p = 0.007$), as well as, lower ADC.ratio ($p = 0.021$) were observed in clinically significant cancers diagnosed at biopsy. A model combining significant variables diagnosed subsequent significant cancer diagnosis with area under the ROC curve 0.84 (CI 0.72 to 0.94).

Conclusions: The addition of prostate volume, PSA density, clinical stage and ADC.ratio can better stratify PI-RADSV2 assessment category 3 observations into those which may represent clinically significant cancer at biopsy.

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PET/MRI FOR DIAGNOSIS OF PERITONEAL CARCINOMATOSIS: EARLY RESULTS FROM A PROSPECTIVE STUDY

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Purpose: To assess the diagnostic value of PET/MRI for diagnosis and spatial localization of peritoneal carcinomatosis (PC).

Materials and Methods: This prospective study included 12 patients with suspected PC (M/F 3/9, mean age 57y, cancer: colon = 6, appendiceal = 3, ovarian = 1, mesothelioma = 1, gallbladder = 1). Patients underwent FDG-PET/MRI prior to surgery. 2 blinded readers from nuclear medicine and Body radiology evaluated PET, DWI, and contrast-enhanced (CE)-T1W images based on a modified version of Sugarbaker's Peritoneal Cancer Index (PCI) with 4 abdominopelvic regions. Surgical PCI was the reference standard. Spearman correlation was performed for surgical and radiological PCI. ROC analysis was performed at the patient level per modality to determine accuracy for diagnosing significant PC (PCI > 20), a relative contraindication to surgical treatment.

Results: 10/12 patients and 29/48 regions had confirmed PC. Mean surgical PCI was 9.2 ± 8.7 (range 0–24). Mean PET/MRI PCI was 9.6 ± 9 (range 0–27). At the patient level, PET/MRI had sensitivity of 90%, with low specificity at 50%. At the region level, PET/MRI had 79% sensitivity and 58% specificity, compared with DWI (66%/90%), CE-T1W (59%/68%), and PET (38%/89%). Our study showed better per-region sensitivity than published DWI-MRI and PET/CT values, but lower specificity. Radiological PCI of DWI, CE-T1W, PET, and PET/MRI demonstrated significant correlation with surgical PCI: 0.661–0.790 ($p < 0.019$). DWI, CE-T1W, and PET/MRI demonstrated perfect diagnostic performance for detection of PCI > 20 (AUC = 1, $p = 0.013$).

Conclusions: PET/MRI accurately scored PCI at the patient level, but not at the region level. PET/MRI may be not be necessary for diagnosing large tumor burden, as the individual imaging modalities also had excellent diagnostic performance for PCI > 20.

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LONG-TERM OUTCOMES IN PATIENTS WITH INCIDENTAL PANCREATIC CYSTS < 1.5 cm

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Purpose: To assess long-term risk of malignancy in patients with incidental pancreatic cysts < 1.5 cm.

Materials and Methods: In this HIPAA-compliant, IRB-approved retrospective study, the MRI database at our institution was searched for patients with pancreatic cysts ≥ 0.5 and < 1.5 cm in maximal diameter, 2 MRI studies ≥ 6 months apart between 1999 and 2011. Subjects with < 5 years of clinical or radiological follow-up were further excluded from the analysis. Maximal dimension was recorded of the largest pancreatic cyst on initial MRI and of the same cyst on the most recent MRI or CT. Descriptive statistics and confidence intervals were provided.

Results: Out of 283 patients meeting initial inclusion criteria, 214 patients had ≥ 5 years clinical or radiological follow-up (median 10.2 years, range 5.0–18.0 years), median age 61.4 years (range 29.5–88.2 years), females 64%. For 179 patients with ≥ 5 years radiological follow-up, median initial cyst diameter was 1.0 cm and median growth was 0.1 cm (range – 1.2 to 1.5 cm). 1/283 (0.4%, 95% CI 0–2.0%) patients developed pancreatic carcinoma, diagnosed 11 months after initial MRI and located remotely from the cyst, 1/283 (0.4%, 95% CI 0–2.0%) had cystic NET diagnosed by FNA 18 months after initial MRI, and 1/214 (0.5%, 95% CI 0–2.6%) had an enlarging cyst showing high-grade dysplasia on pathology 7 years after initial MRI. In none of these cases was IV contrast essential for interpretation. 34/283 (9.8%) patients expired for unrelated reasons.

Conclusions: The long-term risk of malignancy in patients with incidental pancreatic cysts < 1.5 cm in size is small. Size of the largest cyst was not predictive of malignancy. The only adenocarcinoma developed < 1 year from initial diagnosis and remotely from the cyst. It is unclear if annual imaging can improve outcomes in this patient population.

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PROSPECTIVE ASSESSMENT OF POSITIVE ORAL CONTRAST FOR CT IN THE ED FOR NON-TRAUMATIC ABDOMINAL PAIN

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Purpose: Evaluate the impact of positive oral contrast material (POCM) for non-traumatic abdominal pain on diagnostic confidence, rates of diagnosis, and ED throughput.

Materials and Methods: ED oral contrast guidelines were changed to limit use of POCM. A total of 1437 abdominopelvic CT exams performed for non-traumatic abdominal pain were prospectively evaluated for diagnostic confidence (5-point scale at 20% increments; 5 = 80–100% confidence) over a 6-month period. Impact on ED metrics including time from CT order to exam, preliminary read, and ED length-of-stay (LOS) were evaluated. A subset of cases ($n = 100$) were evaluated for diagnostic rate.

Results: A total of 35 reviewers participated (18 residents, 7 fellows, 10 staff). 659 exams (46%) were done with POCM, 778 (54%) were performed without POCM. For examinations with POCM, 85% of reviewers gave a diagnostic confidence score of 5 (mean 4.84 ± 0.40 ; $99\% \geq 4$). For exams without POCM, 64% received a score of 5 (mean 4.56 ± 0.66 ; $93\% \geq 4$; $p < 0.001$). Trainees scored 819 reviews (57%) and showed a slightly lower diagnostic confidence in cases without POCM compared with faculty (mean, 4.48 ± 0.67 vs. 4.65 ± 0.64 ; $p < 0.001$). Diagnostic rate was 62% in the POCM group versus 57% without POCM. CT order to exam time decreased by 31 min, order to preliminary read decreased by 32 min, and ED LOS decreased by 40 min in the group without POCM compared to those with POCM ($p < 0.001$ for all).

Conclusions: Limiting use of POCM in the ED for non-traumatic abdominal pain decreased ED LOS but impaired diagnostic confidence and may decrease diagnostic rates. Trainees were more impacted by this change than faculty.

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RETROGRADE PYELOGRAM: IS IT NECESSARY TO EVALUATE UNOPACIFIED URETER SEEN ON CT UROGRAM?

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Purpose: To assess the utility of retrograde pyelography (RPG) for evaluating unopacified ureteral segments on CT urography.

Materials and Methods: In this retrospective study, we searched the radiology database over a 1-year period (11/1/2017–10/30/2018) for patients who had a CT urogram (CTU) and then retrograde pyelogram within 180 days. Images and reports were reviewed.

Results: 93 patients underwent a CT urogram with follow-up RPG over the search period. 44/93 (47%) were performed because the CTU described at least one area which did not opacify on excretory phase imaging. 53 ureters were evaluated in these 44 patients. Of the 53 ureters evaluated, 4 ureters (7.5%) showed an abnormality on follow-up retrograde pyelogram—2 revealed a stricture at the unfilled segment, and 2 revealed contour irregularity in the distal ureter, with biopsy revealing urothelial cell carcinoma. Of these 2 cases of urothelial cell carcinoma, abnormalities were identified on the CTU: in one case, an irregular bladder mass near the affected ureter and in the other case, the unopacified area was focally abnormal.

Conclusions: There is a relatively low yield for detecting ureteral abnormalities when a retrograde pyelogram is performed after a CT urogram to evaluate an unopacified ureteral segment—7.5% in our study, with only two of these unopacified regions containing

urothelial cancer (3.8%). In these two cases, suspicious findings were present on the CT urogram and RPG may be unnecessary for follow-up of unopacified ureteral segments if the ureters are otherwise normal-appearing and there is no hydronephrosis.

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PREVALENCE OF STRUCTURAL CAUSE OF HEMATURIA ON CT UROGRAPHY IN YOUNG ADULTS

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Purpose: CT urography (CTU) is an established imaging study indicated for evaluating hematuria in adults who do not have a known or likely source. Dose saving techniques are typically used in younger patients since the incidence of carcinoma is low in this population. This study intends to evaluate adults 35–49 years old in five-year interval age groups who underwent CTU for hematuria to assess whether there is a higher-risk group.

Materials and Methods: The study reviewed 388 CTUs in patient presenting with hematuria between the ages of 35–49 from 1/1/2016 to 12/31/2017. Outside and postsurgical studies were excluded. Radiology reports and images were reviewed for findings to explain the patient's hematuria. Reports from subsequent cystoscopy with pathology were reviewed when available.

Results: 357 patients were included with 116 patients aged 35–39, 92 aged 40–44, and 149 aged 45–49. 35 studies were excluded. There was no significant difference between the groups in patients presenting with microscopic or gross hematuria ($p < 0.05$). No cause of hematuria was found in 75.2%, 76.1% and 70.7% of patients, respectively. Each age group had two patients with findings suspicious for urothelial carcinoma, all of whom had reported gross hematuria. No CTUs were suspicious for RCC. There was no significant difference in the incidence of stone disease or urinary tract malignancy between age groups ($p = 0.05$).

Conclusions: Positive CTU studies are not significantly different among the age groups 35–39, 40–44 and 45–49 years old. This should be considered in evaluating imaging screening thresholds for this population with low incidence of carcinoma.

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SAFETY OF SHORTENED OBSERVATION TIME AND NO RADIOGRAPHIC FOLLOW-UP FOR PATIENTS AFTER CT-GUIDED LUNG BIOPSY

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Purpose: To determine whether 1 h observation after CT-guided lung biopsy (CTLB) without chest X-ray (CXR) in patients without immediate post-procedure pneumothorax (PTX) is sufficient to detect short-term complications.

Materials and Methods: Consecutive patients that underwent CTLB between 01/05/2015 and 06/19/2017 were included in this IRB-

approved HIPAA-compliant study. “Immediate post-procedure PTX” was defined as one detected by CT at the end of the biopsy; “observation PTX” and “delayed PTX” as one detected by CXR during and after the post-procedural monitoring period, respectively.

Results: 441 lung biopsies for 409 patients (average age 68 ± 11 years, 231 female patients) were performed; 75 biopsies were excluded for immediate post-procedure PTX and 6 had insufficient documentation in the electronic records. In 19/360 (5.3%) biopsies, the patient became symptomatic (chest pain, shortness of breath) during post-procedural observation with 1/19 (5%) developing PTX occurring during the monitoring period. In 313/341 biopsies, the asymptomatic patient had no CXR after the procedure, with 6/313 patients (1.9%) developing delayed PTX 3–10 days after the procedure (average 6 ± 3 days). In 28/341 biopsies, the asymptomatic patient underwent CXR within 4 h with no PTX detected. 1/28 patients (3.6%) presented with delayed PTX 7 days after the procedure. When no immediate post-procedural PTX was present, the rate of observation PTX and delayed PTX was 1/360 (0.3%) and 1.9% (7/360), respectively.

Conclusions: Obtaining routine post-procedure CXRs in patients without immediate post-procedural PTX after CTLB is not necessary given the low likelihood of PTX. Furthermore, monitoring these patients for an hour appears safe.

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ONCOLOGIC OUTCOMES IN PATIENTS REFERRED TO A MULTIDISCIPLINARY PANCREAS CANCER PREVENTION CLINIC

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Purpose: Family history, genetic mutations, and pancreatic cystic lesions such as intraductal pancreatic mucinous neoplasms (IPMN) and mucinous cystic neoplasms (MCN) are risk factors for pancreatic adenocarcinoma (PA). We established a pancreas cancer-prevention clinic (PC) to enable optimal work up of high-risk patients (pts). We describe the preliminary oncologic outcomes in pts referred to PC.

Materials and Methods: Institutional IRB waived formal review for this QA project. A retrospective review of imaging and clinical data including reason for referral, surgical, endoscopic ultrasound, and pathological results was performed. Pts with high-grade dysplasia (HGD), MCN, and/or non-PA solid lesions were considered to have surgical lesions.

Results: 1006 pts were enrolled in PC from 1/2016 to 12/2018. 28 pts underwent surgical resection. 20/28 pts were referred for incidentally detected pancreatic cystic lesions on prior imaging. 1/28 pts had a remote history of breast cancer and BRCA2. 2/28 had positive family history. 7/28 pts had history of pancreatitis, abdominal pain, or pancreatic insufficiency. Histopathology revealed PA in 3 pts (0.3%; 2 with IPMN, 1 with MCN). Other diagnosis included IPMN with low-grade dysplasia (LGD; $n = 17$), IPMN with HGD ($n = 3$), MCN

without dysplasia ($n = 1$), MCN with HGD ($n = 1$), solitary pancreatic neuroendocrine tumor (PNET; $n = 1$), solid pseudopapillary neoplasm ($n = 1$), and chronic pancreatitis ($n = 1$). 1 pt with MCN also had a concomitant PNET; 1 pt with IPMN with LGD also had a serous cystic neoplasm. CT or MRI showed worrisome features or high-risk stigmata in 25/28 pts and in 10/10 pts with PA or surgical lesions.

Conclusions: 1% of pts referred to the multidisciplinary PC had malignant and/or surgical pancreatic lesions. Imaging showed signs of aggressive disease in all malignant or surgical lesions.

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