Computed diffusion-weighted MRI in prostate cancer

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PURPOSE

Computed diffusion weighted imaging (cDWI) is a recently proposed technique that produces any b-value images from DWI acquired with at least two different b-values. This exhibit aims to demonstrate the tips and pitfalls for applying cDWI in clinical practice effectively.

CONTENT ORGANIZATION

- Concept of cDWI
- Theoretical advantages of cDWI
- Clinical advantages of cDWI
- What cautions should be taken
- Future clinical perspectives

SUMMARY

Computed DWI technique could offer several advantages such as:
- high b-value DW images with good image quality can be obtained regardless of the MR system’s configuration
- DWI can yield images with contrast and spatial-resolution satisfactorily; this technique may play a more important part in evaluating cancer stage in the future.

On the other hand, radiologists should know the computed DW images are highly influenced by the apparent diffusion coefficient of original images.
Prostate MRI: DCE is necessary or not?

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1. Multiparametric MRI (mpMRI)

1) Definition: T1 + T2 + DW + DCE MRI
2) Role: detection (or screening), staging, and post-treatment follow-up
3) Application in PI-RADSv2
   (1) PZ: DW + DCE MRI
   (2) TZ: T2 + DW MRI

2. Biparametric MRI (bpMRI)

1) Definition: T2 + DW MRI
2) Rationale
   (1) Major sequence in PI-RADSv2: T2 and DW MRI
   (2) DCE: limited capability in discriminating low-grade PCa from inflammation, Gd-related complications, cost-effectiveness, and additional examination time
   (3) Study data: comparable AUC in detecting PCa between mpMRI and bpMRI

3. Necessity of DCE

1) Recent study data: positive DCE findings increased cancer detection rate even in same PI-RADSv2 score
2) Insufficient data for bpMRI in staging or post-treatment follow-up
3) In general, oncologic imaging in the other body parts emphasizes on DCE characteristics

4. Future directions

1) Rigorous studies in terms of clinical impact of bpMRI-missed csPCa
2) Advanced T2, DW, or new noncontrast MR imaging techniques to overcome current limitations of bpMRI
3) Or consideration of new imaging position of bpMRI for replacing TRUS, not for mpMRI
Prostate biopsy with multiple samples using a standardized template under transrectal ultrasound (TRUS) guidance is the current standard diagnostic approach in suspicion of prostate cancer (PCa). The European Association of Urology (EAU) guidelines suggest an extended 10- to 12-core transrectal random biopsy (RB) scheme to decrease false-negative results and improve staging. Nevertheless, 20-30% of clinically significant cancers, mainly in the anterior and apical part of the prostate, are missed using this method. Upgrading and upstaging based on prostatectomy histology is very common.

Prostate MRI is becoming increasingly used in clinical practice in the diagnostic pathway for prostate cancer. MRI may add value as both a pre-biopsy risk assessment tool that may influence the decision whether to perform biopsy as well as a minimally invasive method for tumor localization to direct targeted biopsy for detection of clinically significant prostate cancer.

Since the Prostate Imaging Reporting and Data System (PI-RADS) v 2 was introduced in 2014, The PI-RADS v2 set technical and reporting standards for consistent interpretation and communication of multiparametric MRI. On PI-RADS v2, the approach is divided according to the location of the lesions. If the lesion is located in transitional zone, the first modality of evaluation is T2 weighted image. If the lesion shows grade 3 or 4 lesion, the evaluation about DWI follows. If the lesion is located in peripheral zone, the first modality is DWI followed by DCE.

Prostate MRI has been endorsed more commonly in the setting of a negative biopsy, but there is evolving data on its use in men with no prior prostate biopsy, with the aim of maximizing the detection of clinically significant disease while reducing the detection of clinically insignificant disease.

In this talk, several studies and concerns regarding the role of prostate MR in men with previous negative biopsy and in men with no previous biopsy as well as the role of MR in screening prostate cancer will be discussed.

The use of pre-biopsy MRI, in conjunction with traditional clinical parameters and secondary biomarkers, may allow more accurate risk stratification and assessment of need for prostate biopsy.
Cutting edge in prostate MRI

MC 04 GU-04 15:00
Biparametric prostate MR imaging: prebiopsy role in diagnosing Gleason score 7 or greater prostate cancer

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PURPOSE: To investigate the diagnostic performance of prebiopsy bpMRI or PSA-based parameters, and their combination in identifying GS 7 or greater PCa.

MATERIALS AND METHODS: Sixty eight patients who underwent prebiopsy T2-weighted (T2WI) and diffusion-weighted imaging (DWI) and biopsy were included. Pathologic results of 12-core systemic and target biopsy with/without surgery were reference standard. An experienced radiologist analyzed bpMRI. Qualitative analyses comprised Prostate Imaging Reporting and Data System version 2 (PI-RADSv2) and recently modified version (mPI-RADSv2) by Rosenkrantz et al. Quantitative analyses comprised mean or 10th percentile tumor apparent diffusion coefficient (mADC; 10th ADC), and mean or 10th percentile ADC ratio between benign tissues and PCa (mADCR; 10th ADCR). Prostate-specific antigen density (PSAD) was measured. Area under the curve (AUC) of logistic models using prebiopsy parameters for identifying GS 7 or greater PCa was investigated (model 1, PSAD+PI-RADSv2; model 2, PSAD+mPI-RADSv2; model 3, PSAD+mADC; model 4, PSAD+10th ADC; model 5, PSAD+mADCR; and model 6, PSAD+10th ADCR).

RESULTS: Rate of GS 7 or greater PCa was 45.6% (31/68) from biopsy and 57.4% (39/68) from combined biopsy and surgical results. AUCs of model 1 to 6 were 0.860, 0.880, 0.837, 0.844, 0.811, and 0.806 for biopsy GS 7 or greater (p > 0.05 in all comparisons), and 0.831, 0.836, 0.821, 0.841, 0.808, and 0.811 for biopsy or surgical GS 7 or greater, respectively (p > 0.05 in all comparisons).

CONCLUSION: Combined analysis of PSAD and prebiopsy bpMRI is useful for identifying GS 7 or greater PCa.

MC 04 GU-05 15:10
Is biparametric MRI sufficient for the localization of prostate cancer?

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PURPOSE: To compare the sensitivity of prebiopsy biparametric (BP) MRI with post-biopsy pre-surgical multiparametric (MP) MRI for the localization of clinically significant prostate cancer based on whole mount prostatectomy specimen.

MATERIALS AND METHODS: We included 41 patients (age: 64.3 ± 6.2 [mean ± standard deviation], prostate-specific antigen (PSA): 8.8 ± 4.9 ng/dL [mean ± standard deviation]) who underwent (1) BP MRI (T2-weighted and diffusion-weighted MRI) before MR/ultrasound fusion biopsy, (2) postbiopsy MP MRI, and (3) radical prostatectomy with histopathologically confirmed clinically significant prostate cancer (csPCa), which was defined as Gleason scores (GS) ≥ 7 cancer or GS 6 cancer with more than 0.5 cm³ volume. Two radiologists, who had 14 (reader 1) and two years (reader 2) of experience in prostate MRI, respectively, reviewed BP and MP MRI independently with localizing and evaluating suspicious lesion using prostate imaging-reporting and data system (PI-RADS) version 2. Agreement between MR specified lesion and csPCa in the prostatectomy specimen was determined by consensus of two readers. Post-biopsy hemorrhage (appeared as high signal intensity on T1 weighted image) amount was also assessed as a four-point Likert scale: 1, 0-25%; 2, 25-50%; 3, 50-75%; 4, 75-100% of the prostate volume. Diagnostic performance was compared between the two reviewers using McNemar tests. The greatest dimension of PI-RADS 4 and 5 lesions were compared between BP and MP MRI by Wilcoxon signed rank tests. Also, weighted Cohen’s kappa was used for evaluating interobserver agreement in post-biopsy hemorrhage.

RESULTS: The sensitivities of localizing csPCa on BP and MP MRI were 78% and 80% for reader 1; 73% and 68% for reader 2, respectively. The differences between the readers and MRI sequences were not statistically significant. The mean greatest dimension of PI-RADS 4 and 5 lesions were compared between BP and MP MRI by Wilcoxon signed rank tests. Also, weighted Cohen’s kappa was used for evaluating interobserver agreement in post-biopsy hemorrhage.

RESULTS: The sensitivities of localizing csPCa on BP and MP MRI were 78% and 80% for reader 1; 73% and 68% for reader 2, respectively. The differences between the readers and MRI sequences were not statistically significant. The mean greatest dimension of PI-RADS 4 and 5 lesions measured by reader 2 was significantly decreased on MP MRI, compared with BP MRI (p = 0.025). Evaluation of postbiopsy hemorrhage amount showed good interobserver agreement (κ = 0.627) between two readers.

CONCLUSION: BP prebiopsy MRI was sufficient to localize and evaluate csPCa compared with conventional MP MRI.

CLINICAL RELEVANCE: For screening a prostate cancer in patients with elevated PSA, time-saving BP MRI is useful, which showed no significant difference in
The results of histogram based pattern analysis showed the non-normal distribution in all ROIs. APT-CEST reflected heterogeneous components within prostate cancer region. The averaged rAPTR in prostate cancer ROIs was 77.5%, higher than that in the TZ. However, rAPTR in the PZ was not significantly different from that in the prostate cancer ROIs (O2) (rAPTRmean = -40%).

CONCLUSION: This preliminary study showed that prostate APT-CEST MRI is feasible in prostate cancer using histogram based pattern analysis. The cancer region had different APTR change from transitional zone significantly. Therefore, APT-CEST MR may provide the additional information about the prostate cancer in addition to the anatomical prostate MR imaging.
of PC and PZ are somewhat different from each other. However, TZ showed no significant differences of texture characteristics from that of PC. This may explain the more difficulties in differentiating PC which are located in TZ than in PZ in daily practice with prostate MRI.

**CONCLUSION:** Some texture parameters of prostate cancer and peripheral zone are significantly different in T2WI of prostate MRI. The texture analysis by using the GLCM can be used for the characterization and differentiation of prostate cancer, normal prostatic peripheral zone, and transition zone.

**MC 04 GU-08 15:40**

**PI-RADS version 2: optimal time range for determining positivity of dynamic contrast-enhanced imaging in peripheral zone prostate cancer**

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**PURPOSE:** To analyze optimal time range for determining positivity of dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) in peripheral zone (PZ) prostate cancer (PCa).

**MATERIALS AND METHODS:** Institutional Review Board approved this retrospective study. Eighty-nine patients with PZ PCa who had undergone subtraction DCE MRI were included. Based on surgical pathology for lesion location, an experienced radiologist visually analyzed the earliest time when the optimal tissue contrast between the index tumor and PZ on DCE MRI was achieved. The signal intensity ratio of index tumor-to-PZ at the best contrast time was measured. The optimal cutoff time to discriminate clinically significant cancer (CSC) from insignificant cancer (CIC) was investigated, and a less experienced radiologist also estimated the optimal cutoff time to identify CSC. Diagnostic performance and interobserver agreement of the two radiologists were analyzed.

**RESULTS:** The best contrast time was significantly earlier in CSC than in CIC (median, 48 seconds vs. 90 seconds; p < 0.001), and the signal intensity ratio at the best contrast time was significantly higher in CSC than in CIC (median, 3.2 vs. 1.2; p < 0.001) for an experienced radiologist. The optimal cutoff time to identify CSC was 72 seconds or less for an experienced reader. With the cutoff time, area under the curve for diagnosing CSC was 0.840 for an experienced radiologist and 0.710 for a less-experienced radiologist. Weighted kappa for determining positivity in 72 seconds or less was 0.622 between the two radiologists with different experience.

**CONCLUSION:** Imaging findings in 72 seconds or less after the contrast agent injection seem to reliably determine positivity of DCE MRI for PZ PCa.

**MC 04 GU-09 15:50**

**Impact of contour distortion by transrectal probe on prostatic volume estimation during transrectal US**

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**PURPOSE:** To assess the effect of the contour distortion due to compression by ultrasound (US) probe on the measurement of prostate volume by transrectal US (TRUS).

**MATERIALS AND METHODS:** We included 61 patients who were performed TRUS for health screening and had the image data obtained contour distorted image and not distorted image at the same time from September 2015 to December 2016. We measured and recorded volume of prostate gland and transition zone by prostate ellipsoid formula on distorted and not-distorted image. We compared the difference between two groups (distorted and not distorted) by using statistical methods (Wilcoxon signed-rank test for prostatic volume, paired t-test for transition zone [TZ] volume). We also checked the difference on PSA density (PSAD), TZ-PSAD between two groups by using paired t-test.

**RESULTS:** The volume of prostate gland and transition zone differed significantly between two groups (p < 0.01). PSAD and TZPSAD also differed significantly (p < 0.01). The volume of prostate gland and transition zone of distorted group were smaller than that of not distorted group.

**CONCLUSION:** Contour distortion during TRUS make the difference on the measurement of volume of prostate gland, transition zone, PSAD, and TZPSAD. So we have to try to minimize the contour distortion during TRUS.
Uterine cancers refer to different types of cancers occur in the uterus. Pathologically, uterine cancers are classified as (1) epithelial carcinoma (such as, endometrioid cancer, papillary serous carcinoma, clear cell carcinoma, or carcinosarcoma, which is also known as malignant mixed Müllerian tumors [MMMT]); or (2) stromal/mesenchymal tumors (such as, low-grade endometrial stromal sarcoma, high-grade undifferentiated sarcoma, or leiomyosarcoma). Among them, endometrial cancer is the most common malignancy of the female genital tract in the developed countries. Uterine sarcomas are far less common and account for approximately 1 in 12 of all uterine cancer patients.

Endometrial carcinoma is a relatively manageable disease for gynecological oncologists, because the early symptoms of irregular vaginal bleeding trigger patients to seek care when the disease is at an early and treatable stage. Thus a generally high survival rate is expected. However, data show that the mortality rate for uterine cancer has increased more rapidly than the incidence rate, which has remained stable over the last 20 years. This increased mortality may be related to an increased rate of advanced-stage cancers and high-risk histology type. To further improve on outcome for patients with this disease, a better staging method is demanded and high-risk patients need to be identified, and tailor treatment should be appropriately provided.

The histological tumor grade and the depth of myometrial invasion correlate strongly with the prevalence of lymph node metastasis and with patient survival. The myometrial invasion ratio determines the International Federation of Gynecology Oncology (FIGO) stage thus has a direct influence on treatment. Although clinical guidelines of National Cancer Center Network from the United States require a complete dissection of pelvic and paraaortic nodes regardless of the estimated myometrial invasion, certain European groups advocate a less aggressive surgical approach, with surgical lymphadenectomy only used for patients with deep myometrial invasion. Furthermore, clinical judgment of absent myometrial involvement is critical for young patients with grade I endometrial adenocarcinoma since fertility-preserving treatment may be an option.

Robust imaging armamentarium has continuously been developed since inaccuracy exists by using preoperative tumor grade and intra-operative gross examination of the uterus to evaluate the myometrial invasion depth. A meta-analysis result has showed contrast-enhanced T1-weighted magnetic resonance (MR) imaging substantially better than ultrasonography, computed tomography, and non-enhanced MR imaging, and is further refined by using dynamic contrast enhancement technique for detecting the myometrial invasion. Diffusion-weighted MR imaging (DWI) is recently proven able to differentiate normal and endometrial pathology. The use of high b value makes images more sensitive to water diffusion hence increases contrast between normal and cancerous tissue, in assessing myometrial invasion depth and the presence of cervical stromal invasion.

In this talk we will cover review of the common imaging presentation of uterine cancers originating from various cell types. Imaging features corresponding to the TNM system will be demonstrated, with pearls and pitfalls particularly emphasized. Finally, we will discuss the clinical impact of MR for disease prevention, diagnosis, response evaluation and follow up.
Endometriosis is defined as the presence of endometrial-like stroma and glands outside the uterine cavity, which induces a local inflammatory response. It affects about 5-10% of premenopausal women. Common symptoms of endometriosis include dysmenorrhea, chronic pelvic pain, heavy menstrual bleeding, deep dyspareunia, dysuria, dyschezia and infertility.

There are three forms of pelvic endometriosis: superficial peritoneal lesions, ovarian endometriomas, and deep infiltrating endometriosis (DIE). DIE is defined as an endometriotic lesion infiltrating the peritoneum and penetrating into the retroperitoneal space or the wall of pelvic organs to a depth of at least 5 mm, and affects between 4 and 37% of women with endometriosis. DIE involves in descending order of frequency, the uterosacral ligaments, the rectosigmoid colon, the vagina, and the bladder. Laparoscopy with histologic confirmation is the gold standard test for diagnosing endometriosis, but expensive and carries surgical risks. Furthermore, in the case of advanced extension of DIE, laparoscopy is a difficult procedure with a high rate of complications. Knowledge of as much as detail as possible about the localization, size, number of DIE nodules, depth of infiltration of the DIE nodules, and degree of stenosis of the bowel lumen or ureter, can help in deciding the best treatment strategy for endometriosis, in planning the surgical procedure, in the provision of appropriate counselling to women who undergo the procedure, and in the choice of the right surgical team (e.g., colorectal surgeon or urologist).

Transvaginal sonography and magnetic resonance imaging are used most frequently to identify and characterize lesions in endometriosis. Especially, pelvic magnetic resonance imaging (MRI) can evaluate areas otherwise inaccessible by laparoscopy, identifying and evaluating the extent of lesions in the sub-peritoneal region and in the presence of dense adhesion. Pelvic MRI is useful to more accurately detect deep pelvic endometriosis by accomplishing a complete survey of the anterior and the posterior compartments of the pelvis at the same time. Because of its multiplanar capacity and excellent tissue characterization, pelvic MRI plays an essential role in the preoperative evaluation of patients with deep endometriosis. The MR imaging features depend on the type of lesions: infiltrating small implants, solid deep lesions mainly located in the posterior cul-de-sac and involving the uterosacral ligaments and torus uterinus (retrocervical area), or visceral endometriosis involving the bladder and rectal wall. This lecture will discuss the MR imaging findings of DIE involving anterior and posterior compartments of the pelvic cavity that can be useful for determining the management of the patients with endometriosis.
Renal cell carcinoma (RCC), which accounts for 2% to 3% of adult cancers, accounts for 90% of kidney malignancies and is the most fatal neoplasm in the urological system. Over the past 65 years, the incidence of RCC has increased by 2% every year. The increased incidence is due to improved tumor discovery in the last decades as high-resolution cross-sectional imaging modalities become more available. Most RCCs are asymptomatic at the time of detection and unexpected results are detected in imaging performed for unrelated clinical signs. The World Health Organization classification of adult kidney tumors in 2004 stratified RCC into several distinct tissue subtypes that accounted for 70%, 10%-15%, and 5% of definite cell, nipple and platelet tumors, respectively. Knowledge of the RCC subtype is important because the various subtypes relate to different biological behaviors, prognoses, and treatment options. In addition, common RCC subtypes can often be determined non-invasively, depending on the signal intensity on T2-weighted magnetic resonance imaging, the extent of tumor enhancement on dynamic contrast enhanced computed tomography or magnetic resonance imaging. We will review imaging findings, differential diagnosis, based on recent development of radiologic imaging (CT and MRI) by paying attention to subtypes of RCC.
MC 04 GU-13 17:10
Prediction of lymph node metastasis in endometrial cancer based on pre-operative MR imaging: value of diffusion-weighted imaging
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PURPOSE: To investigate the value of pre-operative magnetic resonance imaging (MRI) including diffusion-weighted imaging (DWI) for predicting lymph node (LN) metastasis in endometrial cancer.

MATERIALS AND METHODS: This Institutional Review Board approved study retrospectively included 390 consecutive patients who received hysterectomy and LN dissection for pathologically proven endometrial cancer. All enrolled patients underwent MRI including DWI before surgery. The MRI findings such as tumor size, presence of enlarged LN, deep myometrial invasion, cervical invasion, and tumor apparent diffusion coefficient (ADC) value were compared between the patients with and without pathologic LN metastasis. Logistic regression analysis was performed to determine the independent MRI predictors of LN metastasis and a statistical model was constructed using the predictors to stratify the risk of LN metastasis in each patient.

RESULTS: LN metastasis was identified in 52 patients (13.3%). Enlarged LN (odds ratio [OR], 6.86; p < 0.001), deep myometrial invasion (OR, 2.52; p = 0.021), cervical invasion (OR, 2.48; p = 0.022), and mean tumor ADC (OR, 0.996; p = 0.006) were independently associated with LN metastasis. According to the statistical prediction model constructed using the imaging variables, 259 (66.4%) and 131 (33.6%) patients were classified as low and high risk group for LN metastasis, respectively. Of low risk group, 7 patients (2.7%) revealed LN metastasis, while 45 of 131 high risk patients (34.4%) had LN metastasis.

CONCLUSION: Pre-operative MRI findings including tumor ADC have predictive value for identifying endometrial cancer patients at low risk of LN metastasis.

MC 04 GU-14 17:20
3 tesla diffusion weighted imaging in ovarian masses: an intriguing clairvoyance to malignancy
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PURPOSE: To evaluate the diagnostic performance of diffusion weighted imaging (DWI) in evaluating ovarian masses with suspicious features on magnetic resonance imaging (MRI).

MATERIALS AND METHODS: This study was conducted at Gujarat Imaging Centre Post Graduate Institute of Radiology, Ahmedabad over a span of 12 months. A total of 100 female patients were included in the study, who were referred for MRI examination of pelvis. In this study, pelvic routine MRI with Diffusion weighted imaging was performed in 100 patients with complex and solid ovarian masses using 3 Tesla Phillips Achieva MRI using torso coil. Diffusion weighted imaging was also acquired with b values: 0, 500, 1000. Visual analysis of the diffusion weighted images was correlated with routine MRI sequences. Histopathologic follow-up of the patients was obtained.

RESULTS: In our study, benign lesions were found in 38 patients (38%), borderline (low potential malignancy) in 22 (22%) and malignant in 40 (40%). Restricted diffusion was observed in most of the invasive malignancies. Benign and borderline tumors showed diffusion restriction intensity in 16% and 28% respectively on diffusion weighted images (p < 0.05).

CONCLUSION: DWI along with conventional MRI data can confirm or exclude malignancy in suspicious ovarian masses. Although combined analysis of quantitative and qualitative criterion with knowledge of the sequence pitfalls is quintessential for the final diagnosis.

MC 04 GU-15 17:30
Incremental value of US in small renal mass (< 4 cm) with T2 low signal intensity to differentiate fat poor angiomyolipoma and renal cell carcinoma
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PURPOSE: To evaluate the incremental value of gray-scale ultrasound (US) in the differentiation of fat poor angiomyolipoma (AML) from renal cell carcinoma (RCC) in case of inconclusive diagnosis after use of both CT and MR.

MATERIALS AND METHODS: Forty-one consecutive patients who had renal mass with low signal intensity
on T2-weighted image without macroscopic fat were retrospectively evaluated who had undergone US. They were pathologically confirmed as AML (n = 18) and RCC (n = 23; 7 clear cell, 9 chromophobe and 7 papillary RCC). Age, gender, size, presence of signal drop on chemical shift image, and echogenicity were recorded by reader blinded to the pathology. Echogenicity was evaluated as five degrees, which were 1 = hypo-, 2 = iso-, 3 = hyperechoic compared to renal cortex, 4 = marked hyperechoic similar to renal sinus fat, and 5 = hypoechoic with bright dots. The statistical analysis was done using T-test, chi-square, and Fisher exact tests.

RESULTS: The median age of patients was 52 (range, 26-77) and the average tumor size was 1.99 cm (range, 0.8-3.7 cm). There were no significant differences in age, size, and presence of signal drop between two groups (p > 0.05). There was significant female predominance in AML (p < 0.001). There was overlap in the echogenicity between fat poor AML and RCC, especially in terms of hypo- (16.7% vs. 34.8% in AML vs. RCC, respectively), iso- (16.7% vs. 21.7%), and hyperechogenicity (5.6% vs. 39.1%). However, 4.3% and 0% of RCC showed marked hyperechoic and hypoechoic with bright dots as opposed to 44.4% and 16.7% of AML, respectively. The percentage of those two characteristic US features was significantly higher in fat poor AML compared with RCC (p < 0.001) with 61.1% sensitivity, 95.7% specificity, 91.7% positive predictive value, and 75.9% negative predictive value.

CONCLUSION: Echo patterns of marked hyperechoic mass similar to renal sinus fat or hypoechoic mass with bright dots on US had high specificity and positive predictive value in predicting fat poor AML over RCC in inconclusive cases despite using CT and MR. Those two features can be useful imaging characteristics when differentiating fat poor AML and RCC.

MC 04 GU-16  17:40
Usefulness of contrast-enhanced US (CEUS) in differential diagnosis of solid or cystic renal masses
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PURPOSE: To determine whether contrast-enhanced ultrasound (CEUS) can be used to differentiate benign renal masses such as angiomyolipoma (AML) with minimal fat or complicated cysts from renal cell carcinomas (RCC).

MATERIALS AND METHODS: We retrospectively collected patients with histolopathologically confirmed solid renal masses such as angiomyolipoma, clear cell carcinoma and papillary renal cell carcinoma and complicated cysts who underwent CEUS with SonoVue during May 2012 to March 2017. Two abdominal radiologists reviewed CEUS and were blinded to the final diagnoses. We analyzed rates, grades, patterns of contrast enhancement at arterial phase, heterogeneity of contrast enhancement at nephrographic phase and wash-out pattern at delayed phase compared with adjacent renal cortex of these tumors. The Mann-Whitney test was used to statistical analysis for these parameters.

RESULTS: The study population consisted of 33 patients (13 women and 20 men) with 33 lesions. There were 4 AML, 22 clear cell carcinoma, 5 papillary renal cell carcinoma and 2 complicated renal cysts. Lesion heterogeneity at nephrographic phase was much more seen in RCC than AML (sensitivity = 76%, specificity = 100%, p = 0.002). And wash-out pattern at delayed phase was more seen in RCC than AML (sensitivity = 84%, specificity = 100%, p = 0.001). Lesion hypovascularity at arterial phase was more seen in papillary renal cell carcinoma than clear cell carcinoma (sensitivity = 66%, specificity = 90%, p = 0.05).

CONCLUSION: Lesion heterogeneity at nephrographic phase and washout pattern at delayed phase were useful findings for differentiating small RCC from AML. Hypovascularity at arterial phase was useful for differentiating papillary renal cell carcinoma from other solid renal tumors.

MC 04 GU-17  17:50
Is chest CT always necessary following nephrectomy for renal cell carcinoma? A pilot study in a single tertiary institution
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PURPOSE: In current guidelines, postoperative computed tomography (CT) examination for follow-up still includes abdomen and chest. We retrospectively evaluated the pattern of thoracic recurrence from renal cell carcinoma (RCC) following nephrectomy.

MATERIALS AND METHODS: Between January 2008 and December 2015, thirty nine patients who underwent surgery or medications for recurrent RCC occurring after curative nephrectomy were detected with abdomen or chest CT, or positron emission tomography/CT (PET/CT). All patients had no metastasis before initial nephrectomy. The recurrence was classified into three types according to initial recurrent site: (a) abdomen-only type, (b) abdomen and thorax type, and (c) thorax-only type. The vertebral level of thoracic recurrence was investigated. UCLA integrated Staging System (UISS)
was utilized for risk stratification (e.g., low; intermediate; and high risk).

**RESULTS**: The rate of high risk was 89.7% (35/39) in recurrent RCC. The overall rate of thoracic recurrence, regardless of concurrent abdominal recurrence, was 71.8% (28/39). The rate of thorax-only type was 53.8% (21/39). In thorax-only type, the median level in location was T10 (range, T3-T12). In thorax-only type, only 4 patients had recurrence above T7 level, whose UISS risk was all high.

**CONCLUSION**: This pilot study suggests that the proportion of initial recurrence at the upper lung alone may be very small following nephrectomy for RCC. For RCC without high risk, abdomen CT covering T7 level may be sufficient for follow-up. Current data warrant further multi-institutional study for validation.

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**Recent issues in GU imaging**

**SS 28 GU-01 09:50**

**Comparison of detection rate for uric acid uroliths among variable parameters of CT: phantom study**

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**PURPOSE**: To investigate whether uric acid stone can be detected by reduced radiation dose using 160 mm ultra-wide coverage CT after loading uroliths collected from the human body into the phantom.

**MATERIALS AND METHODS**: This study was approved by IRB. Six uric acid stones (size range from 1.8 mm to 11 mm) derived from the patients were embedded into silicon cylinder model, and then it was inserted into the human phantom along the ureter course. CT scan was undertaken with two sessions (abdominal cavity and pelvic cavity, respectively) with the same silicon model by various combinations of different tube-voltage (100 kVp, 80 kVp, 70 kVp) and tube-current (300 mA, 250 mA, 200 mA, 150 mA, 100 mA) using 160 mm ultra-wide coverage CT. Three radiologists evaluated the presence of uric acid stones in each data set. The radiation dose was reported on CT system after CT acquisition was finished. The reader-averaged detection rate was compared using logistic regression with generalized estimating equation.

**RESULTS**: The radiation dose were from 6.32 mGy (CTDIvol) with 100 kVp and 300 mA, to 0.69 mGy (CTDIvol) with 70 kVp and 100 mA. The overall reader-averaged detection rate was from 50.00 to 88.98. The reader-averaged detection rate showed significant different only in tube-voltage and tube-current of abdomen (p = 0.0004, < 0.0001). The stone over 4 mm was detected in all parameter sets except two parameter sets (70 kVp with 100 and 150 mAs).

**CONCLUSION**: Ultralow-dose CT showed the promising result for uric acid stone detection in a phantom study with profound radiation dose reduction.

**CLINICAL RELEVANCE**: We present the detection rate of the uric acid stone in a variable parameter using a phantom. Our result showed the possible application of ultralow-dose CT, even 70 kVp, for the detection of uric acid stones and clinical study needs to be followed to confirm our results.

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**SS 28 GU-02 10:00**

**Estimation of renal length, quickly, easily and feasibly using axial image on multidetector CT (MDCT)**

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**PURPOSE**: To evaluate feasibility of renal length estimation using CT slice number and thickness through the coefficient value of mathematical modeling on
multidetector CT (MDCT).

MATERIALS AND METHODS: This study enrolled 40 patients (80 kidneys) as a template group and another 10 patients (20 kidneys) as a test group with CT urography. Three simulation methods for the renal length estimation (Le) in a template group were drawn from the angles between the 3D (XYZ) and kidney axes, and the renal length of routine CT images in axial plane: 1) mean angle model, 2) linear fitting model with the representative angle, and 3) linear fitting model with adding a constant. The best off-axis in the oblique coronal plane was measured as a reference standard (Lr) by using postprocessing workstation (Aquarius, TeraRecon, Inc). These 3 methods were applied to the test group. Le of each kidney was drawn in each method. Lr of each kidney in the oblique coronal plane was also measured in a test group. In order to evaluate the performance of 3 simulation methods, the difference between Le and Lr was calculated in each method. Comparison between Le made by 3 simulation methods and Lr was done by Wilcoxon signed-rank test in both template and test groups.

RESULTS: In a template group, the errors (mm) of right and left kidney lengths for 3 methods were as follows: 1) 3.3 ± 1.3 and 2.5 ± 0.3, 2) 3.4 ± 1.4 and 2.4 ± 0.2, and 3) 3.1 ± 1.1 and 2.3 ± 0.1, respectively. In a test group, the errors (mm) of right and left kidney lengths for 3 methods were as follows: 1) 2.5 ± 1.6 and 2.6 ± 2.2, 2) 2.9 ± 1.5 and 2.9 ± 2.4, and 3) 2.7 ± 1.3 and 2.7 ± 2.0, respectively. Average error values of right and left renal lengths for 3 methods ranged from 2.5 to 3.4 mm in a template group and from 2.3 to 2.9 mm in a test group. Le of the all subjects from 3 methods were within 1 cm of Lr. Le from method 2) was most statistically similar to Lr in a template group (p < 0.05). Method 1) showed the most statistical similarity between Le and Lr in a test group (p < 0.05).

CONCLUSION: All 3 mathematical modeling equations were feasible to estimate the renal length with acceptable small errors only by using routine axial images of MDCT. It can be helpful to reduce the time consuming image reconstruction for the measurement of the long diameter of kidney.

SS 28 GU-03 10:10

Predicting the development of surgically induced chronic kidney disease following total nephrectomy using body surface area-adjusted renal cortical volume on CT angiography

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PURPOSE: To predict the development of surgically induced chronic kidney disease (CKD-S) following total nephrectomy by measuring body surface area (BSA)-adjusted renal cortical volume (RCV) on preoperative computed tomography angiography (CTA).

MATERIALS AND METHODS: This retrospective study was approved by the Institutional Review Board, and informed consent was waived. Eighty-three patients with normal preoperative estimated glomerular filtration rate (eGFR) were divided into two groups according to postoperative renal function: group A (CKD-S [-], n = 47) and group B (CKD-S [+], n = 36). Laboratory findings were collected, and BSA-adjusted RCV was measured on CTA. Multiple logistic regression analysis was used to determine the formula to predict the probability of developing CKD-S, and external validation was conducted using a separate validation group (n = 50).

RESULTS: Logistic model revealed that BSA-adjusted total RCV, preoperative eGFR, and reason for operation (kidney donation or renal tumor) were significant factors for predicting CKD-S (p < 0.05). The probability for developing CKD-S can be calculated with the formula: Logit (P [CKD-S (+)]) = (1.790 * I [reason of operation; renal tumor]) + (3.390 * I [preoperative eGFR ≤ 81.25]) + (1.209 * I [BSA-adjusted total RCV ≤ 242.47]) - 4.035. The optimal cut-off value derived from 10,000 bootstrapped samples was ≥ 0.607. The formula was revealed as a good tool on cross and external validation (cross validation, AUC, 0.820; external validation, AUC, 0.802).

CONCLUSION: CKD-S following total nephrectomy can be predicted with the formula based on BSA-adjusted total RCV, preoperative eGFR, and reason for operation.
SS 28 GU-04  10:20
Low tube voltage CT urography protocol using low concentration iodine contrast media and iterative reconstruction algorithm: a multi-institutional study for comparison with conventional CT urography
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PURPOSE: To compare the image quality of low tube voltage CT urography using low concentration iodine contrast media and iterative reconstruction with conventional CT urography.

MATERIALS AND METHODS: Based on previous feasibility study, we prospectively enrolled 338 patients who underwent CT urography in multi-institution. After randomly divided into two groups, two types of excretory CT urography were performed using various vendors’ CT scanners. In study group, low tube voltage and low concentration iodine contrast media CT protocol (LVLC-CTU) was applied. Tube voltage was reduced to 80 kVp and the concentration of 350 mgI/mL Iohexol was injected. In control group, tube voltage was 120 kVp and the concentration of 240 mgI/mL Iohexol was injected. Iterative reconstruction algorithm was applied in LVLC-CTU. Three independent readers performed qualitative image analyses with 5-point scale for overall diagnostic acceptability. Mean attenuation, signal to noise ratio (SNR), contrast to noise ratio (CNR) and figure of merit (FOM = CNR2/effective dose) were measured at urinary tract. The non-inferiority test assessed the diagnostic acceptability between the two protocol groups.

RESULTS: LVLC-CTU protocol showed a significant lower effective radiation dose (5.73 ± 4.04 vs. 8.43 ± 4.38, p < 0.0001). The diagnostic acceptability was lower in study group. However, all subjects showed at least more than standard diagnostic acceptability (score ≥ 3) and the difference resided in the predefined non-inferiority margin subjects. The mean attenuation, were significantly higher in study group along the entire urinary tract (p < 0.0001). The SNR, CNR, FOM tended to be higher in study group without statistically significant differences.

CONCLUSION: The qualitative and quantitative image quality of LVLC-CTU (80 kVp/240 mgI/mL) with IR is not inferior to that of the conventional CTU, while it is beneficial to reduce radiation exposure and total iodine load, especially in patients with BMI < 25.

SS 28 GU-05  10:30
Diagnostic performance of advanced modeled iterative reconstruction applied images for detecting urinary stones on submillisievert low-dose CT
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BACKGROUND: Repetitive CT scans may be an issue in young adults with urinary stones. Therefore, it is important to know how much a dose can be reduced without a significant reduction in the diagnostic performance.

PURPOSE: To compare the sensitivities among the variable advanced modeled iterative reconstruction (ADMIRE) strengths applied to submillisievert (sub-mSv) low-dose CT (LDCT) and standard-dose CT (SDCT) for the detection of urinary stones.

MATERIALS AND METHODS: A total of 92 consecutive patients (M:F = 62:30; mean age, 50.8 years; range, 17-79 years) with urinary stones underwent non-enhanced abdominopelvic CT that consisted of SDCT (120 kVp, 200 mAs) and LDCT (80 kVp, 60 mAs). The LDCT images were reconstructed separately with 5 different strengths of ADMIRE (hereafter, S1-S5) and filtered back projection (FBP). Two blinded radiologists independently recorded a number of urinary stones in the 6 LDCT data sets and SDCT. The sensitivity of each set for detecting urinary stones was compared using the McNemar test.

RESULTS: A total of 309 urinary stones were analyzed. The sensitivities of the 6 LDCT data sets showed no significant difference (FBP, S1-S5, for reader 1, 61%, 61%, 61%, 62%, 63%, and 62%; for reader 2, 47%, 49%, 50%, 50%, 51%, and 51%, p > 0.05, respectively), which were lower than those of SDCT for both readers (reader 1, 88%; reader 2, 81%, p < 0.05, respectively).

CONCLUSION: The sensitivities for detecting urinary
stones showed no significant differences among sub-mSv LDCT with variable ADMIRE strengths and were lower than those of SDCT.

SS 28 GU-06  10:40  
Comparison of detection rate for calcium uroliths among variable parameters of CT: phantom study  
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PURPOSE: To investigate whether calcium stone can be detected by reduced radiation dose using 160 mm ultra-wide coverage CT after loading uroliths collected from the human body into the phantom.

MATERIALS AND METHODS: This study was approved by IRB. Seven calcium stones (size range from 1.3 mm to 8.3 mm) derived from the patients were embedded into silicon cylinder model, and then it was inserted into the human phantom along the ureter course. CT scan was undertaken with two sessions (abdominal cavity and pelvic cavity, respectively) with the same silicon model by various combinations of different tube-voltage (100 kVp, 80 kVp, 70 kVp) and tube-current (300 mA, 250 mA, 200 mA, 150 mA, 100 mA) using 160 mm ultra-wide coverage CT. Three radiologists evaluated the presence of calcium stones in each data set. The radiation dose was reported on CT system after CT acquisition was finished. The reader-averaged detection rate was compared using logistic regression with generalized estimating equation.

RESULTS: The radiation dose were from 6.32 mGy (CTDIvol) with 100 kVp and 300 mA, to 0.69 mGy (CTDIvol) with 70 kVp and 100 mA. The overall reader-averaged detection rate was from 71.50 to 95.27. The reader-averaged detection rate showed significant different between tube-voltage (p < 0.0001) and tube-current (p < 0.0001) in both abdomen and pelvic cavity. The stone over 4 mm was detected in all of the scan conditions.

CONCLUSION: Ultralow-dose CT showed the promising result for calcium stone detection in a phantom study with profound radiation dose reduction.

CLINICAL RELEVANCE: We present the detection rate of the calcium stone in a variable parameter using a phantom. Our result showed the possible application of ultralow-dose CT, even with 70 kVp, for the detection of calcium stones and clinical study needs to be followed to confirm our results.

SS 28 GU-07  10:50  
CT findings of adnexal torsion: a mass-matched case-control study  
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PURPOSE: To assess computed tomographic (CT) findings of adnexal torsion through a matched case-control analysis, with an ovarian mass being as a confounding variable.

MATERIALS AND METHODS: This retrospective, single-institution case-control study included 43 women with adnexal torsion and 43 age- and mass-matched control women. CT images were evaluated independently by two reviewers for the followings: prominent peripheral follicles, uterine deviation, thickened pedicles, a whirl sign, and a navel sign. Comparison of CT findings was performed with the Chi square test and receiver operating characteristic (ROC) curves were obtained to assess the diagnostic performance. Differences between the areas under the ROC curves (AUCs) were compared by using a Delong test.

RESULTS: The CT findings significant for adnexal torsion were uterine deviation toward the side of affected ovary (p = 0.0168) and thickened pedicles with ancillary findings including a whirl sign, a navel sign, and a navel sign. Comparison of CT findings was performed with the Chi square test and receiver operating characteristic (ROC) curves were obtained to assess the diagnostic performance. Differences between the areas under the ROC curves (AUCs) were compared by using a Delong test.

RESULTS: The CT findings significant for adnexal torsion were uterine deviation toward the side of affected ovary (p = 0.0168) and thickened pedicles with ancillary findings including a whirl sign, a navel sign, and uterine deviation facing thickened pedicles (p < 0.0001). Thickened pedicles with ancillary findings had the highest diagnostic accuracy, as measured with ROC curves (AUC, 0.85). Combining uterine deviation toward the side of affected ovary with thickened pedicles with ancillary findings did not increase the performance relative to that of thickened pedicles with ancillary
findings alone. **CONCLUSION:** Thickened pedicles with ancillary findings including a whirl sign, a navel sign, and uterine deviation facing thickened pedicles could be helpful for the diagnosis of adnexal torsion.

**SS 28 GU-08  11:00**  
Preoperative diagnosis of T1 stage urinary bladder cancer: significance of an inchworm sign at 3T  
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**PURPOSE:** We evaluated the MRI at 3 tesla for diagnosing T staging with an inchworm sign in urinary bladder cancer.  
**MATERIALS AND METHODS:** In total, 262 consecutive patients with urinary bladder tumors underwent magnetic resonance imaging (MRI) including T2WI and diffusion weighted image (DWI) preoperatively. Two radiologist interpreted T2WI plus DWI for the diagnosis of T1 stage by detecting inchworm signs. We evaluated the diagnostic efficacy of an inchworm sign for T1 staging statistically.  
**RESULTS:** We detected urinary bladder tumors with inchworm signs in 48 patients. Of 48 patients with inchworm sign, 33 patients were confirmed pathologically as T1 staging (muscle layer invasion) and 15 patients were confirmed as T2 or higher staging. Preoperatively we diagnosed T2 or higher urinary bladder cancers without inchworm signs in 214 patients. But, 43 patients among them were confirmed as T1 staging. False positive were 16.4% (43/262) and false negative were 5.7% (15/262). Sensitivity 92%, specificity 43%, positive predictive value 80%, negative predictive value 69%. So, diagnostic accuracy was 77.8% (171 + 33/262).  
**CONCLUSION:** We can easily diagnose T1 stage of urinary bladder cancer from T2 stage cancer by detecting an inchworm sign on T2WI or DWI.

**SS 28 GU-09  11:10**  
Diagnostic efficacy and complications of US-guided kidney transplant biopsy using cortex-only view  
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**PURPOSE:** To describe ultrasound (US)-guided kidney transplant biopsy using cortex-only view and analyze its diagnostic efficacy and complications.  
**MATERIALS AND METHODS:** Institutional Review Board approved this retrospective study. Between January 2014 and December 2016, a consecutive series of 188 patients who underwent US-guided kidney transplant biopsy using cortex-only view by an experienced radiologist were evaluated (mean age, 46.1 ± 12.5 years; range, 21-79 years). Biopsy time, biopsy distance, biopsy core number, and glomerular number per patient were recorded. Successful biopsy (e.g., success, 10 or more glomeruli; marginal success, 7-9 glomeruli) and complication rates were investigated, based on Banff criteria and Clavien grade, respectively.  
**RESULTS:** Mean biopsy time, distance, and core number were 20.6 ± 6.7 minutes (range, 10-44 minutes), 3.2 ± 0.7 cm (range, 2.1-5.4 cm), and 1.9 ± 0.3 (range, 1.0-3.0), respectively. Mean glomerular number per patient were 20.4 ± 10.0 (range, 0-54). Success and marginal success rates of biopsy were 87.2% (164/188) and 95.2% (179/188). There was no major complication requiring treatment (no patient with Clavien grade 2 or greater), while there were self-limiting minor complications in 5 patients (overall complication rate, 2.7%).  
**CONCLUSION:** US-guided kidney transplant biopsy using cortex-only view is feasible and safe in sampling cortical tissues of kidney transplant.  
**CLINICAL RELEVANCE:** US-guided kidney transplant biopsy using cortex-only view can be one of biopsy techniques for characterizing a cause of renal dysfunction.