

SSC04

Gastrointestinal (Rectal Cancer)

Monday, Nov. 27 10:30AM - 12:00PM Room: E353A

GI MR OI BQ

AMA PRA Category 1 Credits TM: 1.50
ARRT Category A+ Credit: 1.75

Participants

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Sub-Events

SSC04-01 Comparison in Prognosis of Patients with Rectal Cancer between Low- and High-Risk Group Defined by Magnetic Resonance Imaging (MRI)

Monday, Nov. 27 10:30AM - 10:40AM Room: E353A

Participants

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PURPOSE

To compare the prognosis of patients with rectal cancer between low- and high-risk group detected by MRI, who were treated by total mesorectal excision (TME) surgery and selective adjuvant chemoradiotherapy

METHOD AND MATERIALS

Patients with pathology-proven rectal adenocarcinoma and received TME surgery between January 2006 and December 2014 were included in this retrospective study. Patients who were treated with neoadjuvant chemoradiotherapy, and had other malignancies or distant metastasis were excluded. All included patients had been followed-up until December 2016. The risk factors detected by MRI were defined as: extramural depth of tumor invasion larger than 5mm for mid and upper tumor, intersphincteric space invasion for low tumor, extramural venous invasion (EMVI), circumferential resection margin (CRM) involvement. Patients were divided into low- and high-risk group based on the presence of risk factors. Kaplan-Meier method was used to compare the local overall survival (OS), disease-free survival (DFS), and local recurrence (LR) between two groups, and analyze the univariate influence of risk factors of OS, DFS and LR. A Cox proportional hazards regression model was constructed to figure out independent risk factors of OS, DFS and LR.

RESULTS

Sixty-five patients (35.1%) of whole cohort (185) were divided into low-risk group and 120 (64.9%) were divided into high-risk group. Significant difference was demonstrated between low- and high- risk group shown as 3-year actuarial OS (100% vs.87.8%), DFS (92.3% vs.55.7%) and LR (3.1% vs.10.4%). Compared with mrT and mrN, CRM was identified as the independent risk factor of OS (HR 4.70, 95% confidence interval (CI) 1.25-17.66), DFS (HR 2.44, 95%CI 1.24-4.81) and LR (HR 3.92, 95%CI 1.07-14.41) by using the Cox proportional hazards regression analysis. Moreover, EMVI was identified as the independent risk factor of DFS (HR 2.46, 95%CI 1.28-4.73).

CONCLUSION

For patients with rectal cancer, CRM and EMVI status preoperatively assessed by MRI are the most important factors in predicting local recurrence and long-term survival.

CLINICAL RELEVANCE/APPLICATION

Estimating the presence of risk factors by MRI preoperatively can help predict prognosis and make decision of whether patients need to receive neoadjuvant therapy before TME surgery.

SSC04-02 Comparison of Reduced Field-of-View Diffusion Weighted Imaging (DWI) and Conventional DWI Techniques in Assessment of Rectal Carcinoma at 3.0 T: Image Quality and Histological T Staging

Monday, Nov. 27 10:40AM - 10:50AM Room: E353A

Participants

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PURPOSE

To assess the image quality (IQ) and histological T staging of rectal cancer by comparison of reduced field-of-view (FOV) and full FOV DWI sequences at 3T.

METHOD AND MATERIALS

Eighty-one patients with rectal cancer received MR scan of both rFOV DWI and fFOV DWI sequences. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were quantitatively evaluated using paired T test. Two radiologists independently assessed the subjective IQ parameters including image sharpness, distortion, artifacts, lesion conspicuity and overall subjective IQ of both DWI sequences. Wilcoxon signed rank test was used to compare subjective IQ scores and tumor ADCs between DWI sequences. Mean tumor ADCs between DWI sequences were compared in relation to corresponding T staging of rectal cancer by utility of the spearman rank correlation analysis test.

RESULTS

CNR was significantly higher in rFOV DWI than in fFOV DWI (7.15 ± 2.77 vs. 5.39 ± 2.08 , $P < 0.001$). SNR was significantly higher in rFOV DWI than in fFOV DWI (44.17 ± 11.01 vs. 34.76 ± 13.30 , $P < 0.001$). The subjective IQ parameters of rFOV DWI sequence were rated superior to that of fFOV DWI sequence by both readers ($P < 0.001$). There was no significant difference between mean tumor ADC values of rFOV and fFOV DWI sequences (0.991 ± 0.121 vs. $0.100 \pm 0.126 \times 10^{-3} \text{mm}^2/\text{s}$, $P = 0.617$). Apart from T1 stage, T staging of rectal cancer was correlated inversely with ADC values of rFOV DWI ($r = -0.688$, $P < 0.001$) and fFOV DWI sequences ($r = -0.641$, $P < 0.001$).

CONCLUSION

rFOV DWI sequence provided significantly higher image quality and lesion conspicuity than fFOV DWI sequence. Besides, both DWI sequences can be used for evaluation of histological T staging of rectal cancer.

CLINICAL RELEVANCE/APPLICATION

Image quality can be improved by utility of rFOV DWI sequence and is recommended as part of MR study for rectal cancer before total mesorectal excision (TME) surgery

SSC04-03 Colorectal Carcinoma: Ex Vivo Evaluation using q-Space Imaging and its Correlation with Histopathologic Findings

Monday, Nov. 27 10:50AM - 11:00AM Room: E353A

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PURPOSE

To determine the feasibility of ex vivo q-space imaging (QSI) as a method of evaluating the histologic grades of colorectal carcinomas and lymph node metastasis by colorectal carcinomas.

METHOD AND MATERIALS

Twenty colorectal specimens each containing a carcinoma and their resected lymph nodes were imaged with a 3-T MR imaging system equipped with a 4-channel phased-array surface coil. QSI data were obtained by using a spin echo-based single-shot echo-planar imaging sequence: repetition time, 10000 ms; echo time, 216 or 210 ms; field of view, 113 mm x 73.45 mm; matrix, 120 x 78; section thickness, 4 mm without intersection gaps; eleven b values ranging from 0 to 9000 s/mm²; and motion-probing gradients perpendicular to the colorectal wall. Mean displacement (MDP; in μm), zero-displacement probability (ZDP; in arbitrary unit [a.u.]), and kurtosis (K; in a.u.) were calculated from the displacement distribution profiles, and apparent diffusion coefficient (ADC) was also calculated from two b values ($b = 0$ and 500 s/mm²). The MR images were then compared with the histopathologic findings as the reference standard.

RESULTS

In all 20 colorectal carcinomas, the MDP was calculated as $8.85 \pm 0.36 \mu\text{m}$, ZDP 82.4 ± 6.2 a.u., K 74.4 ± 3.0 a.u., and ADC $0.219 \pm 0.041 \times 10^{-3} \text{mm}^2/\text{s}$. With the histologic grades (well, moderately, and poorly differentiated) of the colorectal carcinomas, the MDP ($r = -0.829$; $P < 0.001$) showed a significant inverse correlation and the ZDP ($r = 0.810$; $P < 0.001$) and K ($r = 0.848$; $P < 0.001$) showed a significant positive correlation, while the ADC ($r = 0.104$; $P = 0.673$) showed no significant correlation. Between metastatic lymph nodes and nonmetastatic lymph nodes, the MDP (10.3 ± 1.2 vs. $19.0 \pm 2.0 \mu\text{m}$; $P < 0.01$), ZDP (53.6 ± 16.1 vs. 26.2 ± 2.0 a.u.; $P < 0.01$), and K (61.0 ± 10.9 vs. 25.3 ± 2.7 a.u.; $P < 0.01$) showed significant differences, while the ADC (1.02 ± 0.38 vs. $1.39 \pm 0.09 \times 10^{-3} \text{mm}^2/\text{s}$; $P = 0.095$) showed no significant differences.

CONCLUSION

QSI provides useful diagnostic information for evaluating the histologic grades of colorectal carcinomas and lymph node metastasis by colorectal carcinomas.

CLINICAL RELEVANCE/APPLICATION

By using QSI for patients with colorectal carcinoma, we may have an effective tool to noninvasively diagnose the histologic grades of colorectal carcinomas and lymph node metastasis by colorectal carcinomas.

SSC04-04 Long-Term Follow-Up with MRI during a "Watch-And-Wait" Approach in Clinical Complete Responders after Chemoradiotherapy

Monday, Nov. 27 11:00AM - 11:10AM Room: E353A

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PURPOSE

A 'watch-and-wait' approach is emerging as an alternative to resection in rectal cancer patients with a clinical complete response (CR) after CRT. Follow-up consists of clinical examination, endoscopy and MRI. Limited data exists on what to expect on MRI during follow-up. Aim was to evaluate the morphology of the rectal wall in patients in the watch-and-wait programme and study its evolution during follow-up for watch-and-wait these patients.

METHOD AND MATERIALS

140 patients with a sustained complete response (i.e. no evidence of recurrence on sequential imaging and endoscopy±biopsy examinations) were analysed during follow up within the scope of a 'watch-and-wait' protocol. Patients underwent MRI (and clinical examination and endoscopy) 3-monthly in the first year and 6-monthly during the 2nd to 5th year. Two readers in consensus analysed the rectal wall morphology on the initial post-CRT scan and studied the evolution in morphology on the various sequential follow-up MRIs.

RESULTS

Median follow-up time was 18 months (range 6-82). A total of 801 MRIs were analysed (median 5, range 2-13 per patient). In 9% of patients the rectal wall completely normalised post-CRT. The other 91% showed a fibrotic remnant (64% minimal fibrosis limited to the bowel wall; 21% thick/mass-like fibrosis and 6% irregular/spicular fibrosis). In 92% the rectal wall morphology remained unchanged during long-term follow-up, in 4% initial fibrosis later developed into a normalised wall, in 4% the fibrosis slightly thickened (without evidence of recurrence).

CONCLUSION

In the vast majority of patients with a complete response residual fibrosis is present post-CRT, which remains unchanged during long-term follow-up in almost all patients. A completely normalised wall is observed in approximately 1 in 10 complete responders. These findings may serve as a reference and provide teaching for radiologists involved in the clinical follow-up of patients selected to undergo a watch-and-wait policy.

CLINICAL RELEVANCE/APPLICATION

Knowledge of the evolution of the rectal wall is crucial to allow for safe use of a watch-and-wait approach in complete responders after CRT for rectal cancer.

SSC04-05 Use of Restaging Abdominopelvic CT after Neoadjuvant Chemoradiation Therapy in Patients with Nonmetastatic Locally Advanced Rectal Cancer

Monday, Nov. 27 11:10AM - 11:20AM Room: E353A

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PURPOSE

Neoadjuvant chemoradiation therapy (CRT) before surgery is current standard for locally advanced rectal cancer without distant metastasis, but it delays surgery for several months. We investigated if restaging abdominopelvic CT before surgery after CRT is beneficial given the time lag from the initial diagnosis.

METHOD AND MATERIALS

472 consecutive patients (M:F, 308:164; 62.2±11.8 years) who had newly diagnosed rectal cancer (T3 or N+ as assessed with MRI), no distant metastasis or any lesions that were not cleared of metastasis as evaluated with both CT and PET/CT, and no previous (during past 5 years) or concomitant cancers, underwent long-course CRT. Patients were reevaluated 4-6 weeks after CRT with rectal MRI and restaging abdominopelvic CT (n=231) or with rectal MRI alone (n=218). 23 patients dropped out. Diagnostic yield of the restaging CT for abdominopelvic metastasis was determined. The rate of overlooked abdominopelvic metastasis, defined as lesions that were unexpectedly found during rectal cancer surgery or developed early (within 6 months) after the surgery or CRT (for 8 patients followed without surgery), and the outcome of the overlooked lesions were compared between the two patient groups. Abdominopelvic progression-free survival (PFS) was compared between the two groups.

RESULTS

Diagnostic yield of restaging CT was 2.2% (5/231), all of which were resected with curative intent. Restaging CT created false positives in three patients, causing unnecessary hepatic resection (n=1), RFA (n=1), and follow-up liver MRI (n=1). Restaging CT group had seven patients (3%) with overlooked abdominopelvic metastasis; four patients found during the surgery, three of whom could be operated with curative intent, and three patients as early postsurgical metastasis, one of whom was amenable to curative-intent treatment. The no CT group had seven patients (3.2%) with overlooked metastasis; all as early postsurgical metastasis, three of whom were amenable to curative-intent treatment. These rates did not significantly differ ($P=1$). Abdominopelvic PFS did not significantly differ between the two groups ($P=.426$).

CONCLUSION

Restaging abdominopelvic CT after CRT for locally advanced rectal cancer does not have a clear benefit due to its low yield, insufficient exclusion of metastasis, and unignorable risk of false-positives.

CLINICAL RELEVANCE/APPLICATION

This study recommends against restaging abdominopelvic CT after CRT for rectal cancer.

SSC04-06 PET/MRI in Patients with Pelvic Recurrence of Rectal Cancer: Technical Feasibility and First Clinical Experiences

Monday, Nov. 27 11:20AM - 11:30AM Room: E353A

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PURPOSE

Accurate diagnosis of pelvic recurrence of rectal cancer is crucial in determining further treatment, especially prior to surgical resection. So far, PET/MRI has not been widely used in this setting. The purpose of this study was to determine the value of PET/MRI in the pre-therapeutic staging and management of patients with pelvic recurrence of rectal cancer.

METHOD AND MATERIALS

Out of 57 patients with a history of rectal cancer who received PET/MRI between June 2011 and July 2016 at our institution, 34 patients were retrospectively enrolled in the study. 23 patients were excluded because they were lost to follow-up. One patient received two PET/MRIs, thus a total number of 35 examinations was included. Pelvic recurrence was confirmed either with histology (biopsy n=5, surgery n=21) or clinical and imaging follow-up (>6 months). Two blinded readers (1 radiologist, 1 nuclear medicine physician) interpreted the images in consensus. Pelvic lesions were assessed regarding FDG-uptake, morphology, contrast enhancement and diffusion restriction. Sensitivity, specificity, positive and negative predictive value as well as accuracy of PET/MRI were determined.

RESULTS

In 35 PET/MRIs 26 pelvic lesions were identified, out of which 25 were deemed suspicious for pelvic tumor recurrence. One lesion was thought to be a vesicovaginal fistula. 24 of the 25 lesions were confirmed as malignant. One patient was resected and had histologically proven pelvic recurrence without suspicious findings on PET/MRI. Changes in management due to PET/MRI findings were implemented in 2 patients (metastasis sacral nerve=1, penile metastasis=1), 83% of resected patients had histologically negative resection margins (R0). The sensitivity of PET/MRI in detecting recurrence was 96%, specificity 92%, positive/negative predictive value and accuracy were 96%, 92% and 95%, respectively.

CONCLUSION

PET/MRI demonstrates high sensitivity and specificity in the preoperative diagnosis and staging of pelvic recurrence in patients with rectal cancer.

CLINICAL RELEVANCE/APPLICATION

PET/MRI is a valuable tool in the preoperative diagnosis and staging of pelvic recurrence in patients with rectal cancer, aiding in achieving high rates of R0-resection.

SSC04-07 Interobserver Reproducibility in Assessing the Response after Neoadjuvant Chemoradiation Therapy for Locally Advanced Rectal Cancer Using Magnetic Resonance Tumor Regression Grade (mrTRG)

Monday, Nov. 27 11:30AM - 11:40AM Room: E353A

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PURPOSE

Methods to assess the response after neoadjuvant chemoradiation therapy (CRT) for locally advanced rectal cancer on post-CRT MRI have been proposed, of which magnetic resonance tumor regression grade (mrTRG) is seemingly most recognized. However, interobserver reproducibility of mrTRG has hardly been evaluated outside those who developed the mrTRG system. This study is to assess the interreader reproducibility of mrTRG externally.

METHOD AND MATERIALS

50 pairs of pre- and post-CRT (obtained 4-6 weeks after the finish of CRT) rectal MRI sets obtained in 50 patients (M:F, 36:14; 65.5±12.4 years), who were randomly chosen from a consecutive cohort of 439 patients who underwent long-course CRT for a newly diagnosed locally advanced rectal cancer (T3 or N+ stage as seen on pre-CRT MRI, no distant metastasis, and no other previous or concomitant cancers), were included. Before the study, three abdominal radiologists experienced with rectal MRI went through an educational session consisting of a review of 50 training cases collected outside the study cohort and reading of relevant articles. The three readers assessed the CRT response for this study using mrTRG (1 to 5) independently blinded to any other information than the history of CRT. We analyzed interreader reproducibility regarding the description of individual mrTRG (1 to 5) as well as regarding the binary interpretation of mrTRG1 and 2 (i.e., good response) vs. 3-5, using weighted kappa with linear weights and the conventional kappa, respectively. For mrTRG1 and 2 vs. 3-5, the proportional agreement was also obtained.

RESULTS

According to the consensus interpretation among the three readers, the mrTRG distribution in the study patients was 14% mrTRG1 (n=7), 26% mrTRG2 (n=13), 32% mrTRG3 (n=16), 28% mrTRG4 (n=14), and 0% mrTRG5. The weighted kappa for describing the individual mrTRG (1 to 5) was 0.62 overall and 0.60 to 0.62 for individual reader pairs. The kappa for mrTRG1 and 2 vs. 3-5 was 0.65 overall and 0.57 to 0.72 for individual reader pairs. The proportional agreement in interpreting mrTRG1 and 2 vs. 3-5 was 83% overall and 80-86% for individual reader pairs.

CONCLUSION

mrTRG showed a substantial interobserver reproducibility, which further supports its implementation for use in clinical practice and trials.

CLINICAL RELEVANCE/APPLICATION

mrTRG could be used fairly reliably in clinical practice and trials to guide further treatment after neoadjuvant CRT for rectal cancer.

SSC04-08 Assessing FDG-PET/3-T MRI after Preoperative Chemoradiotherapy for Rectal Cancer

Monday, Nov. 27 11:40AM - 11:50AM Room: E353A

Participants

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PURPOSE

To assess the accuracy of pelvic 3-T MRI and combined FDG-PET/3-T MRI (PET/MRI) in predicting pathological tumor and node (ypTN) stages, and to compare the accuracy of whole-body PET/MRI with thoraco-abdominal CT (CT) in predicting metastases (ypM) stage.

METHOD AND MATERIALS

This prospective study concerned 17 patients (16 male) with locally advanced rectal cancer who underwent preoperative chemoradiotherapy, PET/MRI and CT for staging purposes. PET/MRI included T2 and diffusion weighted images. Total mesorectal excision was the treatment of choice for 13 patients; the remainders were MRI node negative and underwent transanal local excision with at least 1-year endoscopic and pelvic MRI follow-up. Concurrent distant metastases were confirmed by surgery/biopsy or followed up with CT. One radiologist assessed pelvic MRI and CT images. Another radiologist and a nuclear medicine physician jointly assessed PET/MRI findings. All three were blinded to all other imaging and pathology results.

RESULTS

ypT was T0 in 4 patients, T1 in 3, T2 in 1, T3 in 7, and T4 in 2. ypN was positive in 5/17 cases, and metastases were detected in 3/17 patients. MRI and PET/MRI findings for ypT were concordant and correct in 11/17 patients (64.7%), concordant and incorrect

in 2/17 (11.8%), and discordant in 4/17 (23.5%), PET/MRI staging being correct in 2 cases. As for ypN staging, MRI and PET/MRI were concordant and correct in 14/17 patients (82.3%) and discordant in 3/17 (17.7%), with PET/MRI staging predicting ypN status in 2 cases. Two patients with metastases were diagnosed correctly, while PET/MRI misdiagnosed one case of a small lung metastasis.

CONCLUSION

Integrated whole-body PET/MRI improves the accuracy of ypTN staging, but is less accurate than CT in ypM staging. Further studies are needed, including efforts to refine PET/MRI by using specific sequences for the lung and intravenous gadolinium, to examine the role of this technique in monitoring distal cancer spread. If successful, it would be possible to combine local and distant rectal cancer staging in a single examination.

CLINICAL RELEVANCE/APPLICATION

FDG-PET/3-T MRI can be a useful tool for the whole-body staging (TNM) of patients with advanced rectal cancer after chemoradiotherapy.

SSC04-09 Tumor Heterogeneity MRI Features Improve Machine Learning-Based Prognostication in Patients with Metastatic Colon Cancer

Monday, Nov. 27 11:50AM - 12:00PM Room: E353A

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PURPOSE

Intra-tumor heterogeneity has been previously shown to be an independent predictor of patient survival. The goal of this study is to use machine learning to assess the role of quantitative MRI-based measures of intra-tumor heterogeneity as predictors of survival in patients with metastatic colorectal cancer.

METHOD AND MATERIALS

In this IRB-approved retrospective study, we identified 52 patients with stage 4 colon cancer who underwent MRI from 2007-2013 for liver metastasis evaluation. Patient survival data was available for up to 95 months. Standard clinical and pathologic prognostic variables were extracted from the medical record. The largest metastatic hepatic lesion was identified on portal venous phase T1-weighted fat-suppressed post-contrast images and manually segmented. A heterogeneity phenotype vector was extracted from each lesion by using quantitative texture analysis as a measure of spatial heterogeneity. Univariate regression analysis was used to assess for independent contribution of 32 extracted texture features to survival prediction. A linear support vector machine (SVM) machine learning technique was applied to the extracted heterogeneity phenotype vector and to the standard prognostic clinical and pathologic variables. The classifiers were trained and tested using 10-fold cross validation to avoid overfitting. ROC analysis and the area under the curve (AUC) were used to assess classification performance. Delong's test was used to assess for differences between ROC curves.

RESULTS

Mean survival time was 39±3.9 months for the study population. Tamura texture features, directionality, coarseness and contrast were independently associated with patient survival ($p<0.01$). The trained SVM model that included standard clinical and pathological prognostic variables resulted in an area under the ROC curve of 0.80. An SVM model that adds imaging-based heterogeneity features to the clinical and pathological variables resulted in improved model performance for survival prediction with an AUC of 0.98 ($p<0.001$).

CONCLUSION

MRI-based texture features improve the performance of standard clinical and pathological variables for predicting patient survival in metastatic colorectal cancer.

CLINICAL RELEVANCE/APPLICATION

Machine learning-based predictive models incorporating quantitative MRI heterogeneity features may improve prognostication and personalize treatment choices in patients with metastatic colon cancer.