Diagnostic Accuracy of Multidetector-row Computed Tomography Study in Assessment of Mesorectal Fascia Invasion for Staging of Rectal Cancer Patients in Comparison with Magnetic Resonance Imaging

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PURPOSE

To assess the accuracy of current generation multidetector-row CT scanner by using multiplanar reconstructions (MPR) in identifying the mesorectal fascia (MRF) invasion, in rectal cancer patients, in comparison with conventional MRI.

METHOD AND MATERIALS

A total of 79 patients with biopsy proven primary adenocarcinoma of the rectum who were referred for thoracic and abdominal CT staging were enrolled in this study. The contrast-enhanced MDCT scans were performed both on a 256 row scanner (ICT, Philips) and on 16 row scanner (Brilliance 16P, Philips) with the following acquisition parameters: tube voltage 120 KV and tube current 150-300 mAs (depending on patient’s weight). Multiplanar CT reconstructions were performed and the imaging data were reviewed as axial images and then as MPR images: coronal, sagittal, perpendicular and parallel along with rectal tumour axis. The MRF was readily identified in all patients as a thin, isodense to muscle, curvilinear envelope adjacent to the rectum and the mesorectal fat. The MR study, performed on 1.5 T with a dedicated phased array multicoil, included multiplanar T2 weighted sequences and axial T1 weighted sequences. Axial and MPR CT images were then compared to MRI imaging in order to assess the involvement of MRF. Diagnostic accuracy of both modalities was compared and statistically analyzed.

RESULTS

All the CT scan studies were diagnostic in terms of detection of rectal cancer; among the 79 patients, the tumor characteristics suggested by multidetector-row CT agreed with those of MRI. All the patients underwent to surgical rectal excision. Considering the row CT axial images, the overall sensitivity and specificity were respectively 82.6% and 70%, PPV was 79%, NPV 74% and accuracy of 77%; while performing multiplanar reconstructions the sensitivity increased to 87% and specificity to 85%, PPV was 89%, NPV 82% and accuracy of 86%.

CONCLUSION

CT technique with new generation of scanner, by producing high resolution images, represents a useful and reliable diagnostic tool in the assessment of loco-regional and whole body staging of patient with locally advanced rectal cancer.

CLINICAL RELEVANCE/APPLICATION

MDCT, producing higher resolution and multi-planar reformation of the images, should be considered as alternative technique in rectal cancer staging, especially in patient with MRI contraindications.
PURPOSE
To compare reformatted images from three-dimensional (3D) CUBE T2-weighted fast spin-echo MR sequence with tri-planar images acquired two-dimensional (2D) T2-weighted fast spin-echo sequence in terms of image quality and accuracy of T staging of rectal cancer.

METHOD AND MATERIALS
58 patients (mean age, 58.4 years; range, 26-80 years) with rectal cancer confirmed by colonoscopy and biopsy were enrolled in this study. All patients underwent pelvic MRI examination at 1.5 T. MRI sequences included a single coronal 3D CUBE T2-weighted fast spin-echo MR sequence with 1.4-mm-thickness and a 2D T2-weighted fast spin-echo sequence in the sagittal, coronal, and axial planes with 5-mm-thickness. The other two planar images of 3D CUBE sequence were reconstructed at GE AW4.5 workstation with 5 mm thickness and no interslice gap. The total acquisition times of two sequences were calculated. Qualitative analyses of image quality and conspicuity between tumor and normal tissue were performed. Two radiologists experienced in colorectal cancer independently assessed the T-stage of local tumor in CUBE and T2-weighted image according to the depth of tumor invasion, circumference and length of intestine involved and the results were compared with histological results respectively. Quantitative values, qualitative scores were analyzed by using the paired t test, Wilcoxon signed rank test, respectively.

RESULTS
Mean acquisition time of 3D sequence (384s) was significantly shorter than the acquisition time of 2D sequences in three planes (718s) (p <0.05). Although both readers reached a consensus that 3D CUBE yielded significantly lower image quality than 2D MRI (p < 0.05), tumor conspicuity was superior with the 3D sequence (2.78±0.85 vs 2.21±0.73, t=8.24, P < 0.05), and 3D sequence offered similar accuracy in T stage of rectal cancer compared to 2D sequence (35/58 vs 33/58; t=1.76, P=0.08).

CONCLUSION
Despite a lower overall image quality, but because of time savings and the versatility of reconstructing images in any orientation without compromise of diagnostic accuracy in T stage of rectal cancer, the 3D CUBE T2-weighted fast spin-echo sequence showed certain advantages compared to 2D T2-weighted fast spin-echo sequences.

CLINICAL RELEVANCE/APPLICATION
Compared with 2D T2-weighted FSE sequence, 3D CUBE T2-weighted FSE sequence produces a great savings of time and offers a greater tumor conspicuity and the ability to perform multiplanar reformation.

Magnetic Resonance Imaging-detected Extramural Venous Invasion: Significant Prognostic Factor in Rectal Carcinoma

PURPOSE
To compare the incidence of disease relapse between rectal cancer patients with positive MRI-detected extramural venous invasion (mrEMVI) and those with negative mrEMVI and evaluate the relapse-free survival rates between the two groups

METHOD AND MATERIALS
A total of 263 patients (166 men, 97 women; mean age: 61 years, range: 20-85 years) with biopsy proven rectal carcinoma without metastasis at initial staging were enrolled in this study. All patients were staged using preoperative 3T rectal MRI, chest/abdomen CT and PET/CT scan and underwent follow-up imaging studies after operation at least for 3 years. Two radiologists reviewed all MR images and gave a consensus regarding MRI-EMVI score (five-point scale; 0-2: negative, 3-4: positive). All follow-up images were evaluated for local recurrence or metastasis. The incidences of disease relapse were compared between the two groups (mrEMVI-positive or negative) using Chi-square test. The relapse-free survival rate was analyzed using the Kaplan-Meier method and the differences between the groups were compared using the log rank test.

RESULTS
Of 263 patients, there were 69 (26.2%) patients with mrEMVI-positive rectal carcinoma. Of these patients, 42% (29/69) developed local recurrence or metastases during follow-up period, which were compared to 9.8% (19/194) of those with negative mrEMVI. There was significant difference in the incidence of relapse between two groups (p < .001). The patients were followed for a median of 52 (range, 3-76) months. The 5-year relapse-free survival rate was 89.4% in patients with mrEMVI-positive rectal cancer which was significantly higher than 56.4% in patients with mrEMVI-negative rectal cancer (p < .001).

CONCLUSION
The patients with mrEMVI-positive rectal cancer demonstrated higher disease-relapse rate and lower relapse-free survival rate than those with negative mrEMVI-negative rectal cancer.

CLINICAL RELEVANCE/APPLICATION
Preoperative evaluation of mrEMVI may predict the prognosis of patients with rectal carcinoma.
**SSA07-04 MRI Tumor Heterogeneity as a Potential Prognostic Imaging Biomarker in Patients with Rectal Cancer Treated with Neoadjuvant Chemoradiotherapy**


**PURPOSE**

To assess the prognostic significance of heterogeneity of rectal tumours on MRI, quantified by texture analysis in patients treated with neoadjuvant chemoradiation.

**METHOD AND MATERIALS**

Retrospective analysis of 29 consecutive patients with rectal cancer with 1.5T rectal MRI pretreatment and 6 weeks post neoadjuvant chemoradiation Tumor heterogeneity was quantified on the T2 axial small field of view image with the largest tumour diameter, using TexRAD, a commercially available software. This used filtration-histogram based texture analysis technique to extract pixel size based (fine, medium, coarse) features and quantified histogram parameters including Kurtosis (K), skewness (S) and normalized standard-deviation (SDn). Kaplan-Meier analysis compared texture parameters with overall (OS) and disease-free survival (DFS). Mean follow-up was 39.4 months.

**RESULTS**

4 patients showed complete pathological response. Median OS and DFS was 52.3 (95% CI: 40.5-64.0) and 37.3 (95% CI: 15.3-59.2) months respectively. On pre-treatment MR, lower SDn and higher K/S were significantly associated with reduced OS for different texture scales (medium scale: SDn <0.52, p=0.0007; K>1.58, p=0.017; S>0.9, p=0.018) and lower SDn and K were significantly associated with reduced DFS for different texture scales (medium texture scale: SDn <0.52, p=0.0068; K<-0.27, p=0.0195). At 6 weeks post treatment, an increase in SDn and decrease in K/S were associated with poor prognosis (medium texture scale: SDn >8.1%, p=0.0431; K<-50.8%, p=0.018; S<-0.12, p=0.041). Pathological response, tumor stage, nodal stage and circumferential resection margin status were not significant predictors of OS and DFS.

**CONCLUSION**

Pre-treatment and 6 weeks post chemoradiation rectal tumor MRI texture parameters were associated with reduced OS and DFS. Changes in biological parameters such as tissue hypoxia may be reflected by changes in tumour heterogeneity.

**CLINICAL RELEVANCE/APPLICATION**

Tumour heterogeneity on pretreatment and 6 weeks post chemoradiation rectal MRI may be useful in predicting poorer clinical outcome and provide opportunity to target those patients suited for intensive management.

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**SSA07-05 Diagnostic Efficacy of Diffusion-weighted MR Imaging in the Evaluation of Tumor Response to Neoadjuvant Chemoradiation Therapy, in Patients with Locally Advanced Rectal Cancer, Correlated with Tumor Regression Grade at Histology**

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**PURPOSE**

To assess the diagnostic value of quantitative apparent diffusion coefficient (ADC), as a predictor of tumor response to neoadjuvant chemo-radiation therapy (CRT) in patients with locally advanced rectal cancer (LARC), by analysing pre and post CRT values of ADC, correlated to tumor regression grade (TRG) obtained by histopathologic analysis.

**METHOD AND MATERIALS**

A total of 70 patients with locally advanced rectal cancer (≥T3 or lymphnode positive) were evaluated before and after CRT treatment. Each patient scan consists of multiplanar T2 and T1 combined with diffusion-weighted sequences using a 1.5T MRI system(Achieva,Philips). For each patient dedicated workstation was used to evaluate the quantitative apparent diffusion coefficient (ADC) pre- and post-CRT MR images, by outlining freehand region of interest (ROIs) on the site of the lesion. Diagnostic accuracy of ADC values for predicting treatment response correlated with histopathological tumor regression grade (TRG) was evaluated, according to Mandard's classification [responders (TRG1-2) and non-responders (TRG 3-5)].

**RESULTS**

Patients were assigned to the tumor responders group ( n = 48) or the tumor non-responders group ( n = 22) on the basis of histopathologic examination results following surgery. Before CRT, there wasn't significant difference in ADC value between responders vs non-responders: the mean tumor ADC values in the responders group was 1444.46 × 10-3 mm2/sec ± 231.49 than in the nondownstaged group 1267.47 × 10-3 s/mm2. The post-CRT ADC values were correlated to histopathologic tumor regression grade (TRG), and ROC analysis demonstrated the
best cut-off value of 1,298 x 10^{-3} \text{ mm}^2/\text{sec}, in determining responders patients yielding a sensitivity of 86% and specificity of 72%.

CONCLUSION
The quantitative assessment of post-CRT in ADC map, represents a non-invasive feasible tool useful in the re-staging of patients with locally advanced rectal cancer (LARC), having good relationship with histology.

CLINICAL RELEVANCE/APPLICATION
The post-CRT ADC values showed comparable relative accuracy as a predictor of tumor response to neoadjuvant chemo-radiation therapy (CRT) to tumor regression grade (TRG) obtained by histopathologic analysis.

SSA07-06 Performance of Texture Analysis, Diffusion Weighted Imaging and Perfusion Imaging in Predicting Tumoral Response to Neoadjuvant Chemoradiotherapy in Rectal Cancer Patients Studied with 3T MR
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PURPOSE
To determine the performance of texture analysis (TA), diffusion weighted imaging (DWI), and perfusion MR (pMR) in predicting tumoral response in patients treated with neoadjuvant chemoradiotherapy (CRT).

METHOD AND MATERIALS
The patient population consisted of 12 patients with rectal cancer, who underwent pre-treatment 3T MRI. Texture analysis (kurtosis), apparent diffusion coefficient (ADC) and pMR parameters (IAUGC, Ktrans, Ve, Kep) were quantified using commercial research software algorithms. After CRT, all patients underwent complete surgical resection and the surgical specimen served as the gold standard. Receiver operating characteristic (ROC) curve analysis was performed to assess the discriminatory power of texture parameters to predict complete response.

RESULTS
Pathological complete response (pCR), partial response (PR) and no response (NR) were found in 6, 3 and 3 patients, respectively. Baseline kurtosis was significantly lower in pCR in comparison with PR+NR (p=.01). Among ADC and pMR parameters, only Ve was significantly lower in the pCR compared to PR/NR (p=.01). A significant negative correlation between kurtosis and ADC (r=-0.650, p=0.022) was observed. The areas under the curve (AUC) to discriminate patients with pCR from patients with PR/NR were 0.861 for kurtosis, 0.569 for IAUGC, 0.569 for Ktrans, 0.861 for Ve, 0.668 for Kep and 0.556 for ADC. The discriminatory power was significant for kurtosis (p=0.001) and Ve (p=0.003). The optimal cutoff for the identification of pCR was

CONCLUSION
Baseline TA and pMRI parameters have the potential to act as imaging biomarkers of tumoral response to neoadjuvant chemoradiotherapy.

CLINICAL RELEVANCE/APPLICATION
The identification of new imaging biomarkers for early assessment of neoadjuvant treatment response could be helpful in refining rectal cancer patient management, providing a better targeting of preoperative therapy.

SSA07-07 Clinical Impact of the Tumor Volume Reduction Ratio in the Rectal Cancer Patients Following Preoperative Chemoradiation; A Comparison Study of Volumetric Measurement, Down-staging, and Tumor Response Grade
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PURPOSE
To evaluate whether MR volumetric analysis in rectal cancer can predict the clinical outcome, tumor recurrence and disease-free survival (DFS), and to determine the most reliable method for predicting clinical outcome among tumor volume reduction ratio (TVRR), tumor down-staging (TDS), and tumor response grade (TRG).

METHOD AND MATERIALS
Seventy four patients who underwent preoperative concurrent chemoradiation therapy (CCRT) and following curative rectal surgery, between January 2007 and December 2010, were included in this study. Two radiologists being blind to clinical outcome measured tumor volume in consensus before and after CCRT on MRI. Tumor volume was manually traced on each T2 weighted axial image and was calculated by multiplying cross-sectional areas by section thickness. TVRR, TDS of T stage were assessed on MRI. The pathologic TRG, recurrence and DFS were assessed with medical record. We divided patients into two groups according to episode of recurrence. Difference of TVRR between two groups were assessed with student t-test, and the cut-off value of TVRR for predicting recurrence were evaluated with maximal chi-square method. Difference of TDS and TRG between two groups were estimated with chi-square test. The most reliable predicting parameter among TVRR, TDS, and TRG was evaluated with Cox regression analysis.
**RESULTS**

TVRR \((p=0.002)\) and TRG \((p=0.006)\) was significantly different between recurrent and non-recurrent groups, whereas TDS of T stage \((p=0.448)\) was not. Mean follow up time for DFS was 36.98 ± 18.51 months. The cut-off value of TVRR was estimated as 61.38%. Between higher TVRR (>61.38%) and lower TVRR groups, DFS \((p=0.00)\) and TRG \((p < 0.01)\) were significantly different. TVRR was the most reliable predicting parameter.

**CONCLUSION**

After CCRT, TVRR assessment on MRI can be a prognostic parameter for predicting tumor recurrence and DFS, as well as TRG. The cut-off value of TVRR was 61.38% in our study.

**CLINICAL RELEVANCE/APPLICATION**

MR volumetry of rectal cancer can be a helpful predicting factor for clinical outcome in patients with CCRT.

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**SSA07-08**

**The MRI Features of Rectal Cancer Which Achieved Pathological Complete Remission after Neoadjuvant Concurrent Chemoradiation Therapy**

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**PURPOSE**

To depict the MRI characteristics of rectal cancer of which pathological complete remission (PCR: Mandard grade 1) has been achieved by neoadjuvant concurrent chemoradiation therapy (CRT).

**METHOD AND MATERIALS**

We retrospectively analyzed 88 (Male/femal=55/33, age of 58.62±11.24 years) rectal cancer patients who underwent pre-/post-CRT MRI, CRT and surgery between January 1998 and December 2012 and were found to have achieved PCR. Post-CRT MR was obtained 8~54 (23.4±9.9) days before surgery. Tumor distal margin reached lower, middle and upper rectum \((n=49/38/1, 6.0±2.3cm to anal verge)\). We analyzed pre-/post-CRT MRIs to assess tumor circumferential resection margin (CRM), MR T stage (gross perirectal infiltration), volume (volumetry), MR tumor regression grade (TRG), T2 signal intensity (SI) grade (comparing with muscle), residual morphology, diffusion restriction and nodal status. Paired t-test was used to compare pre-/post-CRT tumor volume.

**RESULTS**

Pre-CRT \((24.34±24.37cm3)\) and post-CRT \((7.67±8.99cm3)\) MR revealed a tendency of marked volume decrease \((P<0.001, \text{reduction rate: } 70.6±19.3\%)\). MR TRG G1\((\text{PCR})/G2/G3/G4/G5\text{(marked progression)}\) were 3/23/61/1/0. MR T stage \((\text{T1and2/T3a/T3b/T3c/T4})\) were 14/6/26/35/7\((\text{pre-CRT})\) and 19/13/28/21/7\((\text{post-CRT})\). CRM results (negative/threatening/invasion) were 37/34/17\((\text{pre-CRT})\) and 44/33/11\((\text{post-CRT})\). SI grade (not visible/lower-than-muscle/iso-to-muscle/intermediate high/edema-SI) were 0/0/8/80/0\((\text{pre-CRT})\) and 3/14/50/15/6\((\text{post-CRT})\). Morphologic grade of post-CRT MR (not visible/scanty remnant/subtle soft tissue/gross nodule) were \(3/13/25/47\). DWI was performed in 68 post-CRT MRIs, of which 10 showed diffusion restriction. The post-CRT MR LN grade were (negative/borderline/suspicious=39/44/5), but pathology review identified metastatic LNs in only 2 negative and 2 borderline graded cases. Six patients \((6.8\%)\) later developed tumor recurrence.

**CONCLUSION**

MRI of rectal cancer which achieved PCR after CRT demonstrates highly variable and confusing imaging characteristics. A tendency of marked volume reduction and decreased T2 SI after CRT does exist, but remaining mass and/or enlarged LNs of soft tissue SI are not infrequently encountered.

**CLINICAL RELEVANCE/APPLICATION**

Post-CRT rectal cancer can show highly variable MRI features. Striking remnant mass and/or LNs with bulk showing soft tissue SI does not necessarily neglect the possibility of having achieved PCR.
METHOD AND MATERIALS
In 329 patients with RC (98 female, 231 male; mean age 63.0 (SD 12), mean BMI 26.0 kg/m2 (SD 5) with 218 obese patients BMI >25 kg/m2) who underwent multi-detector-CT, area-based quantification of TAT, VAT, SAT and Ratio VAT/SAT was performed on levels L3/4 and L4/5, and volume-based quantification from T11/12 to L5/S1 (abd) and L5/S1 to symphysis (pelv), between -190 to -30 HU. Logistic regressions of TAT, VAT, SAT and Ratio VAT/SAT on surgical complications (total n=107, anastomotic leakage (AL, n=27), wound infection (WI, n=57), bleeding (n=12), abscess (n=26), bladder dysfunction (BD, n=25), burst abdomen (BA, n=9)) and medical complications (total n=47, cardiac (n=18), pulmonary (n=22)) were performed.

RESULTS
A significant increase was seen in overall medical complications for TAT (p\textsubscript{abd}=0.03; p\textsubscript{pelv}=0.003) and SAT (p\textsubscript{abd}= 0.02; p\textsubscript{pelv}= 0.002); in cardiac complications for TAT (p\textsubscript{abd}=0.02, p\textsubscript{pelv}= 0.01), VAT (p\textsubscript{abd}= 0.03) and SAT (p\textsubscript{pelv}= 0.02); in AL for VAT (p\textsubscript{pelv}= 0.02) and SAT (p\textsubscript{L4/5}= 0.04); in WI for TAT (p\textsubscript{abd}= 0.02, p\textsubscript{pelv}= 0.02) and SAT (p\textsubscript{abd}= 0.04, p\textsubscript{pelv}= 0.01); in BD for TAT (p\textsubscript{abd}= 0.03) and VAT (p\textsubscript{abd}= 0.02, p\textsubscript{L3/4}= 0.02); in BA for TAT (p\textsubscript{abd}=0.003, p\textsubscript{pelv}=0.002, p\textsubscript{L3/4}= 0.007, p\textsubscript{L4/5}= 0.004), VAT (p\textsubscript{abd}=0.005, p\textsubscript{L3/4}= 0.01, p\textsubscript{L4/5}=0.03), SAT (p\textsubscript{abd}=0.006, p\textsubscript{pelv}=0.002, p\textsubscript{L3/4}= 0.03, p\textsubscript{L4/5}= 0.007) and Ratio VAT/SAT (p\textsubscript{L4/5}= 0.01). No association was seen with pulmonary or overall surgical complications, bleeding and abscess. BMI showed no association with any complication.

CONCLUSION
In contrast to BMI, an increase in adipose tissue compartments measured in CT is able to predict complications after RC surgery. No obesity paradox was observed in the sense of a protective effect of adipose tissue.

CLINICAL RELEVANCE/APPLICATION
Quantification of adipose tissue compartments, based on routine CT scans, could (in contrast to BMI) help identify patients at risk for complications following RC surgery, aiming to prevent these.