SUV_{max}-based Parameters of FDG-PET/CT Reliably Predict Pathologic Complete Response After Preoperative Hyperthermo-chemoradiotherapy in Rectal Cancer

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Abstract. *Background/Aim:* To determine the most reliable predictor for pathologic complete response (pCR) in patients who underwent preoperative chemoradiotherapy and regional hyperthermia (HCRT) for rectal cancer. *Patients and Methods:* Thirty-six patients were enrolled. The local control status of the patients was assessed using ¹⁸F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET/CT), magnetic resonance imaging (MRI), and colonoscopy before and after HCRT. The relationships between various parameters of these clinical examinations and pCR were analyzed. *Results:* Ten (28%) patients achieved pCR. The accuracies of predicting pCR using FDG-PET/CT, MRI, and colonoscopy were 78%, 61%, and 75%, respectively. FDG-PET/CT was the only independent predictive modality for pCR ($p=0.021$). The maximum standardized uptake value (SUV_{max}) and SUV_{max} normalized to liver uptake (SLR) after HCRT showed the highest sensitivity (90%) and the decreasing rate of SUV_{max}

and SLR demonstrated the highest specificity (89%) for pCR. *Conclusion:* SUV_{max}-based parameters of FDG-PET/CT after HCRT were the most reliable predictors for pCR.

Preoperative chemoradiotherapy (CRT) is considered as one of the gold standard treatments for patients with locally advanced rectal cancer (LARC) (1). Several randomized studies have shown that preoperative CRT improves the local control rate compared to radiotherapy alone or postoperative CRT in LARC (2, 3). Additionally, a recent pooled analysis showed that patients with pathologic complete response (pCR) after CRT had better overall survival and disease-free survival than patients without pCR (4). Thus, pCR after CRT is a favorable biomarker for patients with LARC.

In an effort to improve pCR rates in LARC, several randomized phase III studies have tested the efficacy of oxaliplatin in addition to fluorouracil-based agents for preoperative CRT (5-7). However, these clinical trials were not successful in improving the pCR rates; rather, they led to significant toxicities. Meanwhile, other studies reported the effectiveness of fluorouracil-based preoperative CRT concomitant with regional hyperthermia (hyperthermo-chemoradiotherapy; HCRT) for LARC. They found pCR rates of 20-22% with a low incidence of toxicities (8, 9).

To date, many studies have reported various predictive factors for pCR after preoperative CRT in LARC. Serum carcinoembryonic antigen (CEA) is the most common tumor marker in patients with rectal cancer. Several studies have

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Key Words: Rectal cancer, chemoradiotherapy, hyperthermia, FDG-PET/CT, pathologic complete response.

Table I. Response criteria for colonoscopies in the present study.

	Complete response	Partial response	Stable disease	Progressive disease
Colonoscopy	No visible tumor, only scarring and telangiectasia, negative biopsy.	Down-staging in T stage, unchanged T stage with decrease in largest diameter $\geq 30\%$.	Unchanged T stage and largest diameter less than 30% with no increase above 20%.	Increase T stage, unchanged T stage with increase in largest diameter $\geq 20\%$.

reported that pre- and post-treatment CEA levels are significant predictors of pCR (10-12). However, this strategy does not apply to patients who have tumors with lower CEA secretion. Moreover, their reliability remains unclear.

On the other hand, in regards to diagnostic imaging, a large meta-analysis showed that magnetic resonance imaging (MRI), computed tomography (CT), and endorectal ultrasonography (ERUS) have a low specificity for the prediction of pCR after CRT for patients with LARC (13). However, in nuclear medicine, a prospective study using ^{18}F -fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET/CT) found better specificity for the prediction of pCR (14), and FDG-PET/CT was regarded to be the most promising imaging modality for the prediction of pCR.

Currently, most of these studies assessing predictive factors for pCR after preoperative CRT in LARC have been performed using only a single tumor marker or imaging modality. Few studies have analyzed the predictive accuracy of pCR using multi-modalities in the same group of patients. The identification of multiple independent predictors of pCR and evaluation of the clinical usefulness are prerequisite for their application in clinical practice. The aim of this study was to retrospectively investigate the most reliable predictors for pCR using multiple diagnostic methods and serum tumor markers in patients who underwent preoperative HCRT for rectal cancer.

Patients and Methods

Design. A retrospective study of patients with rectal cancer who had surgery after HCRT between March 2012 and June 2017 in Hidaka Hospital and Gunma University Hospital was conducted.

Patients. In total, 36 of the 44 consecutive patients that had surgery after HCRT for rectal cancer met the study's inclusion criteria. Inclusion criteria were (i) primary histologically proven adenocarcinoma of the rectum (0 to 12 cm from anal verge); (ii) clinical stage T2-4N0-2 according to the Union for International Cancer Control (UICC) -TNM classification of malignant tumors (15); and (iii) FDG-PET/CT, pelvic MRI, and colonoscopy performed before and after HCRT. The exclusion criteria were (i) distant metastases, (ii) prior chemotherapy or radiotherapy other than HCRT performed before surgery, and (iii) delayed (more than 8 months after HCRT) or cancelled surgery.

All patients underwent preoperative HCRT at the Hidaka Hospital and received pre- and post-HCRT diagnostic examinations,

including FDG-PET/CT, MRI, and colonoscopy. Surgeries were performed at the Division of Surgery at Hidaka Hospital or the Department of General Surgical Science at Gunma University. The present study was approved by the Ethics Committees of Hidaka Hospital (approval number 177) and Gunma University (approval number 2017-248). All patients provided written informed consent.

Treatments. Radiotherapy was performed using an intensity-modulated radiation therapy (IMRT) technique. In the target delineation, the gross tumor volume (GTV) was defined as all the known gross diseases determined from CTs, MRIs, FDG-PETs/CTs, and colonoscopies. The clinical target volume (CTV) was defined as the GTV plus all areas considered at significant risk of harboring microscopic disease, including the mesorectum (perirectal fascia) and the internal iliac, obturator, and presacral lymph regions. The planning target volume (PTV) encompassed the CTV with a 5-mm margin in all directions. The PTV received 50 Gy in 25 fractions; the radiation dose was based on the dose covering 95% of the PTV in IMRT planning. The IMRT was administered daily, 5 times per week using the TomoTherapy Hi-Art Treatment System (Accuray Inc., Sunnyvale, CA, USA). For chemotherapy, capecitabine was administered concurrently at a dose of 1,700 mg/m²/day, 5 days per week during the treatment days. Radiofrequency hyperthermia was administered using the Thermotron-RF8 (Yamamoto Vinita Co., Ltd., Osaka, Japan) once a week for 5 weeks each with 50 min irradiation. The hyperthermia was performed immediately after IMRT during the same day. The precise methods used for thermal therapy have been described in detail in previous publications (16).

Response evaluations. All patients were evaluated using serum tumor markers, colonoscopy, pelvic MRI, and FDG-PET/CT before and after HCRT. Regarding the tumor markers, serum CEA and carbohydrate antigen 19-9 (CA19-9) were used for analysis. In our hospital, the normal limits of serum CEA and CA19-9 were set as <5.0 ng/ml and <37.0 U/ml. A biopsy from the primary lesion was performed in each colonoscopy before and after HCRT. The definitions of the response observed visually upon colonoscopy were based on the Response Evaluation Criteria in Solid Tumors version 1.1 (RECIST ver. 1.1) (17). A patient with only scarring and telangiectasia with a negative biopsy was defined as having a complete response (CR) (Table I). MRI was performed using a 1.5T-MRI (Vantage Titan, Canon Medical Systems Co., Ltd., Otawara, Japan) for all patients. Conventional MRI was performed using T2-weighted sagittal and axial images. Diffusion-weighted imaging (DWI) images were acquired using fixed b-values ($b=0$, $b=1,000$ sec/mm²). The tumor responses in MRI were evaluated according to the RECIST ver. 1.1 (17).

FDG-PET imaging was conducted using a PET/CT scanner (Aquideco, PCA-7000B, Canon Medical Systems Co., Ltd., Otawara,

Table II. Patient characteristics (n=36).

Characteristic	Value
Age years old, median (range)	66 (40-87)
Gender, n (%)	
Male	27 (75)
Female	9 (25)
BMI kg/m ² , median (range)	22.2 (16.5-35.5)
Diabetes, n (%)	
Yes	3 (8)
No	33 (92)
Clinical T stage, n (%)	
cT2	21 (58)
cT3	14 (39)
cT4	1 (3)
Clinical N stage, n (%)	
cN0	18 (50)
cN1	17 (47)
cN2	1 (3)
Distance from anal verge (cm, mean±SD)	3.3±2.5
Histological grade, n (%)	
Well differentiated	12 (33)
Moderately differentiated	23 (64)
Poorly differentiated	1 (3)
CEA before HCRT (ng/ml, mean±SD)	11.3±17.6
CA19-9 before HCRT (U/ml, mean±SD)	35.3±101.6
SUV _{max} before HCRT (mean±SD)	11.0±4.4

BMI: Body mass index; SD: standard deviation; CEA: carcinoembryonic antigen; HCRT: hyperthermo-chemoradiotherapy; CA19-9: carbohydrate antigen 19-9; SUV: standardized uptake value.

Japan) for all patients. Patients fasted for at least 6 h before the scan. Three-dimensional data acquisition was initiated 50 min after the injection of 5 MBq/kg of ¹⁸F-FDG. In the present study, the following parameters were collected from the FDG-PET imaging: maximum and mean standardized uptake values (SUV_{max}, SUV_{mean}), metabolic tumor volume (MTV), total lesion glycolysis (TLG), and SUV_{max} normalized to the liver uptake (SLR). The TLG was defined as MTV multiplied by the SUV_{mean}. The SLR was defined as the SUV_{max} of the rectal tumor divided by the SUV_{mean} of the liver. These parameters were measured and standardized using a SUV-based automated contouring program (GI-PET, AZE, Ltd., Tokyo, Japan). The threshold values for SUV were set to 2.5 in this study, based on the thresholds used in previous studies (18-20). The volume of interest (VOI) was drawn on the area of abnormal FDG uptake corresponding to the rectal tumor in the pre-HCRT scan. Additionally, a VOI of the same size was positioned on the post-HCRT scan; the anatomical landmarks provided by the CT and fusion PET/CT images were considered. The adjacent urinary bladder which could potentially display the high FDG uptake was excluded from the VOI. The tumor responses in FDG-PET were evaluated according to the PET Response Criteria in Solid Tumors (PERCIST) version 1.0 (21). The response index (ResI) considered the decreasing rate of each parameter in “X” FDG-PET and was calculated as follows:

$$ResI = \frac{X \text{ at pre HCRT} - X \text{ at post HCRT}}{X \text{ at pre HCRT}} \cdot 100\%$$

Table III. Surgery and treatment response.

Variable	No. (%) of patients (n=36)
Surgery, n (%)	
Local excision	9 (25)
Low anterior resection	7 (19)
Ultra-low anterior resection	9 (25)
Intersphincteric resection	4 (11)
External sphincteric resection	2 (6)
Abdominoperineal resection	5 (14)
Pathological grade	
pCR	
Grade 3	10 (28)
Non-pCR	
Grade 2	15 (42)
Grade 1	8 (22)
Grade 0	3 (8)
Colonoscopy	
Complete response	7 (19)
Partial response	28 (78)
Stable disease	0 (0)
Progressive disease	1 (3)
MRI	
Complete response	8 (22)
Partial response	27 (75)
Stable disease	0 (0)
Progressive disease	1 (3)
FDG-PET/CT	
Complete metabolic response	8 (22)
Partial metabolic response	27 (75)
Stable metabolic disease	1 (3)
Progressive metabolic disease	0 (0)

pCR: Pathologic complete response; MRI: magnetic resonance imaging; FDG-PET/CT: ¹⁸F-fluorodeoxyglucose positron emission tomography/computed tomography.

Histopathological examination and evaluation of the pathological response to HCRT were performed by experienced pathologists according to the histological criteria of the Japanese Classification of Colorectal Carcinoma (22). Based on these criteria, tumors with a pathological Grade of 0 have no cancer cell necrosis or degeneration. Grade 1 tumors have denaturation, necrosis, and fusion of cancer cells in approximately <2/3 of the tumor while Grade 2 tumors have significant denaturation, necrosis, lytic change, and loss in >2/3 of the tumor. Finally, Grade 3 tumors (pCR) have no viable cancer cells.

Statistical analyses. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal cutoff values for pCR. Univariate analyses were conducted to assess the correlation between clinical factors including diagnostic modalities and pCR. Fisher's exact tests were performed in univariate analysis. Variables with *p*-values <0.15 in the univariate analysis were entered into a multivariate model. Stepwise multivariate logistic regression analysis was used to determine independent factors associated with pCR. The areas under the ROC curve (AUC) with corresponding sensitivities and specificities were calculated for PET parameters. All statistical analyses were performed using R

Table IV. Univariate analysis for the predictors of pathologic complete response.

Factor	pCR (n=10)	Non-pCR (n=26)	p-Value	OR	95%CI
Age (years)					
≤65	2 (12%)	15 (88%)			
>65	8 (42%)	11 (58%)	0.065	5.203	0.813-59.804
Gender					
Female	4 (44%)	5 (56%)	0.226	2.711	0.405-17.879
Male	6 (22%)	21 (78%)			
Clinical T stage					
T2	7 (33%)	14 (67%)	0.468	1.963	0.346-14.407
T3-4	3 (20%)	12 (80%)			
Clinical N stage					
N (-)	7 (39%)	11 (61%)	0.264	3.079	0.546-22.711
N (+)	3 (17%)	15 (83%)			
Distance from anal verge (cm)					
≤3	9 (37%)	15 (63%)	0.115	6.315	0.689-314.549
>3	1 (9%)	11 (91%)			
Histological grade					
Well differentiated	2 (17%)	10 (83%)			
Moderately-poorly differentiated	8 (33%)	16 (67%)	0.438	2.441	0.372-28.200
Gross tumor volume (cc)					
≤30.4	5 (45%)	6 (55%)	0.224	3.209	0.541-20.048
>30.4	5 (20%)	20 (80%)			
Total accumulated irradiation output of hyperthermia (Watt)*					
≤149840	5 (38%)	8 (62%)	0.243	2.724	0.452-17.911
>149840	4 (18%)	18 (82%)			
CEA after HCRT (ng/ml)					
≤2.7	8 (33%)	16 (67%)	0.438	2.441	0.372-28.200
>2.7	2 (17%)	10 (83%)			
CA19-9 after HCRT (U/ml)					
≤7.0	6 (35%)	11 (65%)	0.463	2.005	0.369-12.201
>7.0	4 (21%)	15 (79%)			
Colonoscopy					
CR	4 (57%)	3 (43%)	0.076	4.831	0.633-42.869
Non-CR	6 (21%)	23 (79%)			
MRI					
CR	2 (25%)	6 (75%)			
Non-CR	8 (29%)	20 (71%)	1.000	1.194	0.163-14.532
FDG-PET/CT					
CMR	5 (63%)	3 (37%)	0.024	7.115	1.014-62.708
Non-CMR	5 (18%)	23 (82%)			

pCR: Pathologic complete response; OR: odds ratio; CI: confidence interval; CEA: carcinoembryonic antigen; HCRT: hyperthermo-chemoradiotherapy; CA19-9: carbohydrate antigen 19-9; CR: complete response; CMR: complete metabolic response; MRI: magnetic resonance imaging; FDG-PET/CT: ¹⁸F-fluorodeoxyglucose positron emission tomography/computed tomography; *There were missing data for one patient.

version 3.4.1 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was defined as a *p*-value <0.05.

Results

Characteristics of the 36 patients included in this study are detailed in Table II. The median period from the end of HCRT to surgery was 114 days (range=76-192 days). Total mesorectal excision (TME) was the most commonly performed surgical procedure and was received by 27 patients. Nine of the patients

who exhibited down-staging underwent transanal local excision. The details of all the surgical procedures conducted are listed in Table III. Pathological responses of Grade 3 (pCR), Grade 2, Grade 1, and Grade 0 were observed in 10 (28%), 15 (42%), 8 (22%), and 3 (8%) patients, respectively.

Colonoscopic examinations showed that 7 (19%) patients achieved clinical complete response (cCR) while the MRI evaluations showed that 8 (22%) patients achieved cCR. Additionally, FDG-PET/CT evaluations showed that 8 (22%) patients had complete metabolic response (CMR) (Table III).

The accuracy for the prediction of pCR evaluated using FDG-PET/CT, MRI, and colonoscopy were 78%, 61%, and 75%, respectively. A significant difference was found between CMR and non-CMR in FDG-PET/CT ($p=0.024$). However, the other variables that were evaluated (age, sex, clinical T stage, clinical N stage, distance from the anal verge, histological grade, gross tumor volume, total accumulated irradiation output of hyperthermia, CEA, CA19-9, colonoscopies, and MRIs) were not significantly associated with pCR (Table IV). Multivariate analysis indicated that only FDG-PET/CT was an independent predictive factor of pCR (odds ratio=7.67, 95% confidence interval=1.360-43.100, $p=0.021$) (Table V). Thus, CMR using FDG-PET/CT was considered as the most reliable predictive factor of pCR.

Next, we evaluated which parameter of FDG-PET/CT was the most suitable predictor for pCR (Table VI). None of the PET parameters before HCRT were associated with pCR. Meanwhile, all PET parameters (SUV_{max} , SLR, SUV_{mean} , MTV, and TLG) after HCRT were significantly correlated with pCR. Additionally, the ResIs for all these parameters were significantly correlated with pCR. The highest sensitivity (90%) for pCR was obtained with SUV_{max} , followed by SLR and SUV_{mean} after HCRT. The highest specificity (89%) for pCR was obtained with the ResI of SUV_{max} and SLR. The ResI of SUV_{max} or SLR showed the highest accuracy (83%) for pCR among all PET parameters. SUV_{max} after HCRT was also the most significant parameter for negative predictive value (95%).

Discussion

The present study evaluated the response to HCRT in rectal cancer patients using multiple diagnostic methods and serum tumor markers and investigated the most reliable predictor for pCR. To date, many studies have assessed the predictive accuracy for pCR using a single imaging modality for patients with rectal cancer who received preoperative treatment (13, 23). Conversely, the present study assessed the most reliable modality for the prediction of pCR comparing many diagnostic procedures. We demonstrated that FDG-PET/CT after preoperative treatment was the most reliable modality of pCR for rectal cancer patients. FDG-PET/CT, which originally evaluated the tumor metabolic activity using the glucose metabolism independent of morphological change, is useful for assessing the tumor response to treatment (21, 24). In fact, a recent review showed that response evaluation of FDG-PET/CT was significantly correlated to pCR of rectal cancer after CRT (23).

In the current study, there was no significant difference between the pCR and clinical response evaluation of MRI, colonoscopy, or serum tumor markers. De Jong *et al.* suggested that morphological imaging modalities, such as

Table V. Multivariate analysis for the predictors of pathologic complete response.

Factor	p-Value	OR	95%CI
Age (years)			
>65/≤65	0.116	4.330	0.695-27.000
Distance from anal verge (cm)			
≤3/>3	0.234	4.070	0.404-41.100
Colonoscopy			
CR/Non-CR	0.393	2.750	0.270-28.100
FDG-PET/CT			
CMR/Non-CMR	0.021	7.670	1.360-43.100

pCR: Pathologic complete response; OR: odds ratio; CI: confidence interval; CR: complete response; CMR: complete metabolic response; FDG-PET/CT: ^{18}F -fluorodeoxyglucose positron emission tomography/computed tomography.

CT, MRI, and colonoscopy have limitations in the accuracy of the assessment of their response to therapy in rectal cancer (13). In fact, scarring change, inflammation, and edema may be difficult to distinguish from residual lesions in irradiated rectal cancer using morphological imaging modalities. Additionally, several studies reported that serum CEA before and after CRT have limited accuracy in predicting pCR (25, 26). The present results support these previous findings; conventional morphological imaging modalities or serum tumor markers are not enough to predict pCR of rectal cancer after CRT. Petrillo *et al.* recently reported that dynamic contrast enhanced-MRI (DCE-MRI) was useful for predicting pCR of rectal cancer after CRT (27). In their study, the prediction accuracy of pCR using DCE-MRI and FDG-PET/CT were 79% and 70%, respectively. However, DCE-MRI requires specific software for analysis and quantification, thus limiting its availability in clinical settings compared to that of FDG-PET/CT (27).

The present study also showed which parameters in FDG-PETs/CTs were the most suitable as predictors for pCR. All PET parameters (SUV_{max} , SLR, SUV_{mean} , MTV, and TLG) after HCRT and ResIs for all those parameters were significantly correlated with pCR ($p<0.05$). Among them, SUV_{max} after HCRT was the most significant parameter for the sensitivity and negative predictive value. Furthermore, the ResI of SUV_{max} or SUV_{max} normalized to the liver uptake (SLR) was the most significant parameter for specificity in the present study. Memon *et al.* conducted a systematic review of FDG-PET prediction of pCR in rectal cancer patients (23) in which they found that six of seven studies demonstrated that a low SUV_{max} value after CRT was significantly correlated with pCR. Additionally, seven of nine studies demonstrated that a high ResI of SUV_{max} was significantly correlated with pCR. The present results support these previous findings. SUV_{max} is easily measured

Table VI. Positron emission tomography parameter values for the predictors of pathologic complete response.

Parameter	AUC	p-Value	Cutoff	Sens.	Spec.	PPV	NPV	Acc.
PET before HCRT								
SUV _{max} -pre	0.508	0.247	≥13.5	50%	73%	42%	79%	67%
SLR-pre	0.502	0.119	≥8.4	30%	92%	60%	77%	75%
SUV _{mean} -pre	0.446	0.305	≥6.6	20%	92%	50%	75%	72%
MTV-pre	0.408	0.716	≥31.4	70%	39%	30%	77%	47%
TLG-pre	0.423	0.722	≥197.1	50%	58%	31%	75%	56%
PET after HCRT								
SUV _{max} -post	0.806	0.002	≤3.3	90%	69%	53%	95%	75%
SLR-post	0.817	0.008	≤1.6	90%	62%	47%	94%	69%
SUV _{mean} -post	0.802	0.007	≤2.7	90%	65%	50%	94%	72%
MTV-post	0.775	0.007	≤2.0	80%	73%	53%	91%	75%
TLG-post	0.775	0.007	≤5.3	80%	73%	53%	91%	75%
Response index*								
ResI _{SUVmax}	0.777	0.001	≥79.2%	70%	89%	70%	89%	83%
ResI _{SLR}	0.783	0.001	≥83.3%	70%	89%	70%	89%	83%
ResI _{SUVmean}	0.712	0.018	≥53.6%	70%	77%	54%	87%	75%
ResI _{MTV}	0.767	0.007	≥92.5%	80%	73%	53%	91%	75%
ResI _{TLG}	0.765	0.001	≥96.9%	80%	81%	62%	91%	81%

PET: Positron emission tomography; pCR: pathologic complete response; AUC: area under the curve; Sens: sensitivity; Spec: specificity; PPV: positive predictive value; NPV: negative predictive value; Acc: accuracy; HCRT: hyperthermo-chemoradiotherapy; SUV: standardized uptake value; SLR: SUV_{max} normalized to liver uptake; MTV: metabolic tumor volume; TLG: total lesion glycolysis; ResI: response index; *ResI_X= (X-pre – X-post)/X-pre ×100.

and routinely used in FDG-PET; therefore, SUV_{max}-based parameters (*i.e.* post-treatment SUV_{max}, ResI of SUV_{max}/SLR) of FDG-PET/CT were considered to be the most useful predictors for pCR in clinical practice compared to MRI, colonoscopy, and serum tumor markers.

In measuring SUV, a fixed threshold value of 2.5 was used for SUV and each parameter of FDG-PET/CT was calculated. The threshold of 2.5 for SUV has been used in other reports (18-20), and the threshold was the most reasonable value for the ResI of MTV in rectal cancer patients when compared with threshold values of 2.0 or 3.0 for SUV (19). Hence the threshold of 2.5 for SUV seems to be valid for analyzing treatment response in rectal cancer patients. The measurements could be influenced by a variety of biologic factors such as physique and blood glucose levels (28). To overcome the uncertainty of the SUV value in such situations, the normalized SUV_{max} (for example, SLR, which is the SUV_{max} normalized to liver uptake) is clinically used. Park *et al.* reported that SLR after CRT was a more accurate predictor of pCR than SUV_{max} (19). However, the cohort included in the present study mainly consisted of patients who had an acceptable body mass index (BMI); the median BMI was 22.2 kg/m², and only three patients had diabetes. This may be the reason that there were no differences between SUV_{max} and SLR in the present study. Thus, based on a previous report, SLR may be the best predictor of pCR when assessing patients with obesity or diabetes.

Recently, a “watch-and-wait” strategy has been emerging as a treatment option for rectal cancer after CRT (1, 29). For patients who achieve cCR after CRT, management based on the “watch-and-wait” strategy might be beneficial for organ preservation and maintaining anal functions by avoiding major surgery. However, several studies reported that the local recurrence rate was non-negligible and approximately 15-30% within 2-3 years from CRT when the “watch-and-wait” strategy was chosen for patients who underwent colonoscopy and MRI (30-32). Thus, a methodology for the prediction of the true CR with higher accuracy is greatly required. Considering the results of the present study, SUV_{max} and SLR assessed by FDG-PET/CT may be useful predictors for patients who are treated with the “watch-and-wait” strategy.

In conclusion, the present study demonstrated that FDG-PET/CT was the most reliable modality in prediction of pCR among multiple diagnostic modalities for preoperative treatment in patients with rectal cancer. Furthermore, SUV_{max}-based parameters after preoperative treatment were the most reliable predictors. Further prospective studies are warranted to validate the role of FDG-PET/CT for the prediction of pCR in patients with rectal cancer.

Conflicts of Interest

The Authors have no conflicts of interest to declare.

Acknowledgements

The Authors would like to thank all patients who were involved in this study and our colleagues at Hidaka Hospital and Gunma University Graduate School of Medicine. This work was supported by Grants-in-Aid from the Ministry of Education, Culture, Sports, Science, and Technology of Japan for programs for Leading Graduate Schools and Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering.

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Received August 21, 2018

Revised September 13, 2018

Accepted September 14, 2018