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ORIGINAL ARTICLE

Utility of Preoperative Imaging for Predicting Pelvic Lateral Lymph Node Metastasis in Lower Rectal Cancer

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Abstract

This study aimed to investigate the diagnostic power of preoperative imaging for lateral pelvic lymph node (LPLN) metastasis. A total of 79 patients with advanced lower rectal cancer were preoperatively examined with pelvic enhanced computed tomography and underwent primary resection and LPLN dissection (LPLD) from 2007 to 2014 in our institute. The maximum LPLN was selected to be measured in both the long- and short-axis diameters by picture archiving and communication system (PACS) and was compared with the histopathological results. Receiver operating characteristic (ROC) curves were used to identify the optimal cut-off scores, and we evaluated the accuracy of the thresholds. Twenty-one patients (26.6%) had LPLN metastasis. In the ROC analysis, the criterion of 7.6 mm or larger in the long-axis diameter was used as the optimal threshold for metastasis (area under the curve (AUC) = 0.938) and the criteria of 5.5 mm or larger in the short axis (AUC = 0.946). On the basis of these cut-off scores, the criteria in the long axis represented 95.2% sensitivity, 91.5% specificity, 83.3% positive predictive value (PPV), 98.2% negative predictive value (NPV), and 93.7% accuracy. In contrast, there was 95.2% sensitivity, 89.7% specificity, 76.9% PPV, 98.1% NPV, and 91.1% accuracy in the short axis. Preoperative PACS imaging was considered an optimal tool for diagnosing LPLN metastasis in patients with advanced lower rectal cancer. It is suggested to become the index for considering LPLD adaptation.

Keywords Rectal cancer · Lateral pelvic lymph node · Computed tomography

Introduction

Total mesorectal excision (TME) is the gold standard in surgical treatment for rectal cancer. However, TME alone is unable to eliminate local cancer that has spread beyond the mesorectum. Outside of the mesorectal fascia, lateral pelvic lymph node (LPLN) metastasis has been recognized in approximately 10–25% of cases of advanced lower rectal cancer [1–3]. Therefore, LPLN dissection (LPLD) is a standard procedure for patients with advanced lower rectal cancer in Japan, and previous studies have revealed that it improves survival and local control compared with TME alone [4–7]. However, LPLD has the risk of urinary and sexual dysfunction and is associated with an increased surgical stress [8, 9]; there are cases in which the adaptation of the procedure should be carefully considered.

Recently, the imaging technology has made remarkable progress and the diagnostic power of images continues to improve. Therefore, it is useful to preoperatively elucidate patients who have a high risk of LPLN metastasis using images.

In this study, we retrospectively evaluated the diagnostic accuracy of images, particularly using the picture archiving and communication system (PACS), in predicting LPLN metastasis with lower rectal cancer.

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Patients and Methods

Between November 2007 and July 2014, 79 consecutive patients with advanced lower rectal cancer underwent

Table 1 Patient characteristics

Age (years)	Median (range)	62 (38–77)
Gender	Male:female	59:20
Operative procedure	Anterio resection	38
	Abdominoperneal resection	31
	Total pelvic excteration	7
	Intershincteric resection	2
	Hartmann	1
Maximal tumor size (mm)	Median (range)	60 (6–150)
Historical type	Well differentiated	31
	Moderately differentiated	38
	Poorly differentiated/others	10
Dept of invasion	SM	1
	MP	11
	A	51
	AI	16
Lymph node diameter (mm)	Long axis (median)	5.5 (0.0–29.0)
	Short axis (median)	4.0 (0.0–20.4)

preoperative computed tomography (CT) and bilateral lymph node dissection at the Department of Gastrointestinal Surgery of Kanagawa Cancer Center in Yokohama, Japan. In this study, we included both prophylactic and therapeutic LPLD. The lateral pelvic area was divided into the following six regions on the basis of the Japanese Classification of Colorectal Carcinoma: middle rectal root, obturator, common iliac, internal iliac, external iliac, and aortic bifurcation regions [10].

All patients underwent CT using Aquilion RX or a CML (Toshiba Medical Systems, Tokyo, Japan) and were retrospectively analyzed without knowing the findings of other imaging modalities. Patients were examined in the prone position, and no bowel preparation was administered. The images were obtained using a conventional method with ≥ 5-mm thick sections. All images were managed on PACS and were read with a highly precise monitor so that we could read magnified or reduced images. We used horizontal and coronary slices, and the maximum size of LPLN was selected to be measured in both the long- and short-axis diameters. Border contour and signal intensity [11] were not assessed. The histological results (metastasis or not) of dissected LPLNs were compared with those from CT findings.

Table 2 Image findings and lymph node metastasis

Diameter	No metastasis	Metastasis	*P* value
	$n = 58$	$n = 21$	
Long axis (mm)	50 (0.0–12.1)	10.9 (3.4–29.0)	< 0.001
Short axis (mm)	3.4 (0.0–8.8)	8.0 (2.5–20.4)	< 0.001

Statistical Analysis

The numeric variables were shown as medians, and univariate analysis was performed using the Mann–Whitney *U* test. Differences were considered significant with a P value of < 0.05. Receiver operating characteristic (ROC) curves of both long- and short-axis diameters and the area under the curve (AUC) were generated, and we determined the point nearest to the point (0.1) as the cut-off value for predicting LPLN metastasis.

All statistical analyses were performed using the EZR software program (Saitama Medical Center, Jichi Medical University), a graphical user interface for R (The R Foundation for Statistical Computing, version 2.13.0), or more precisely, a modified version of R Commander (version 1.8-4) designed to add statistical functions frequently used in biostatistics [12].

Results

The median age of the patients was 62 years (range 38–77 years), and the study group included 59 men and 20 women. The clinicopathological characteristics of the patients are shown in Table 1. Of 79 patients, 21 patients (26.6%) had pathological LPLN metastasis.

In patients with lymph node metastasis, both the long and short axes of the maximum lymph node were significantly larger than those of patients without lymph node metastasis (long axis, 10.9 mm vs. 5.0 mm; $P < 0.001$; short axis, 8.0 mm vs. 3.4 mm; $P < 0.001$) (Table 2). The optimal threshold values for predicting metastasis of LPLN was set at 7.6 mm

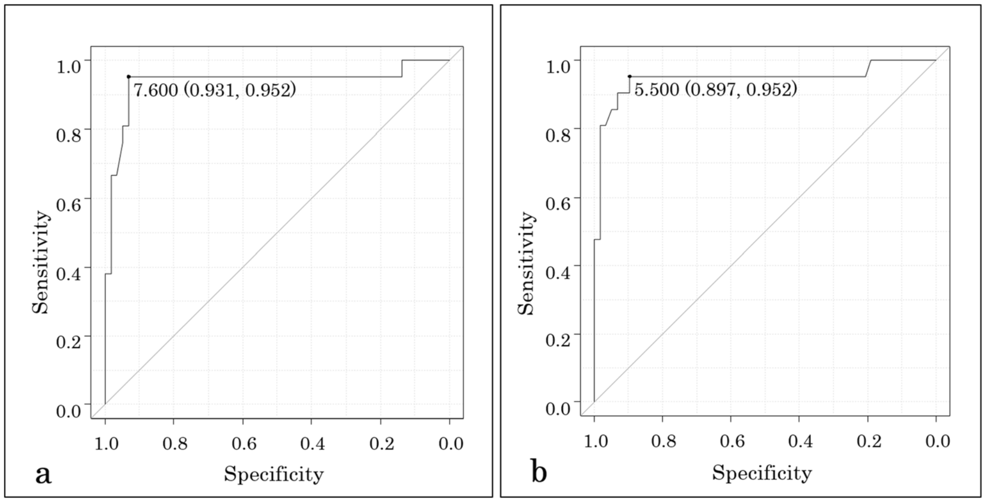

Fig. 1 Receiver operating characteristic curves of the long- and short-axis diameters for predicting the presence of lateral pelvic lymph node metastasis. **a** Long axis. **b** Short axis

for the long-axis diameter and 5.5 mm for the short-axis diameter (Fig. 1). In a comparison of ROC curves, AUC for the long-axis diameter was not significantly different from that for the short-axis diameter (0.938 vs. 0.946; $P = 0.458$; Fig. 2). The sensitivity, specificity, positive predictive value, negative predictive value (NPV), and accuracy of diagnosis using these cut-off scores were 95.2, 91.5, 83.3, 98.2, and 93.8%, respectively, for the long axis. The same figures for the short axis were 95.2, 89.7, 76.9, 98.1, and 91.1%, respectively (Table 3).

Discussion

In our study, the optimal cut-off sizes in CT were set at 7.6 mm for the long axis and 5.5 mm for the short axis, and high-quality diagnostic power was acquired.

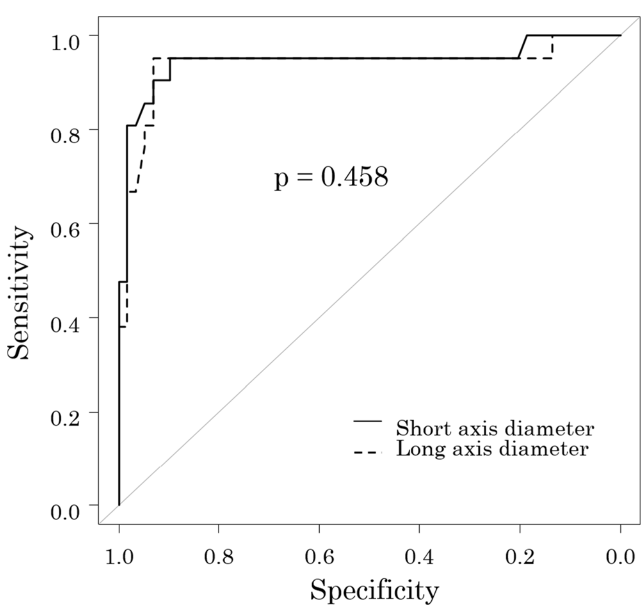

Fig. 2 Comparison of two receiver operating characteristic curves

Until now, several modalities have been reported to be useful for preoperative rectal margin or LPLN evaluation, such as CT, magnetic resonance imaging (MRI), and positron emission tomography (PET). The MERCURY study group of the European multicenter group reported regarding the utility of MRI for the assessment of circumferential resection margin [13]. Yano et al. used CT and set the cut-off value at 5 mm for LPLN metastasis. They reported 95% sensitivity and 94% specificity. Moreover, Fujita used CT and set the cut-off value at 5 mm for the short axis and reported 62% sensitivity, 90% specificity, and 78% accuracy. Akasu et al. [14] used MRI and set the cut-off value at 4 mm for short axis. They revealed 87% sensitivity, 87% specificity, and 87% accuracy. Matsuoka et al. [15] used MRI and set the cut-off value for the short axis at 5 mm for an oval-shaped lymph node and reported 96% sensitivity, 68% specificity, and 82% accuracy. Ogawa et al. [16] also used MRI and set the cut-off value to 5 mm for long axis and reported 80% sensitivity, 56.7% specificity, 95% NPV, and 59.7% accuracy. Watanabe et al. [17] used PET-CT and reported that PET-CT diagnosis alone was not suitable because of its low sensitivity of 23%.

While comparing diagnostic modalities, some studies reported that MRI images were superior to CT images for evaluating tumor staging and mesorectal lymph node metastasis in rectal cancer [11, 18], and some studies demonstrated a superiority of US to CT or MRI [19]. In contrast, Brown et al. [11] reported that size was a poor predictor of nodal status, and border characteristics of nodes were superior to size in predicting mesorectal lymph node metastasis. However, these studies did not include LPLN examination. It was reported that mesorectal and lateral lymph nodes appeared to be different regarding size and shape [20], and the relatively small lymph node size was considered to be difficult to obtain a reliable judgment of border characteristics. Therefore, in this study, we evaluated LPLN using CT, which is the most commonly used

Table 3 Accuracy of imaging

Diameter (mm)	Metastasis	No metastasis	
Long-axis diameter			
≥ 7.6	20	4	PPV 83.3% (20/24)
< 7.6	1	54	NPV 98.2% (54/55)
	Sensitivity 95.2% (20/21)	Specificity 91.5% (54/59)	Accuracy 93.7% (74/79)
Short-axis diameter			
≥ 5.6	20	6	PPV 76.9% (20/26)
< 5.5	1	52	NPV 98.1% (52/53)
	Sensitivity 95.2% (20/21)	Specificity 91.5% (54/59)	Accuracy 91.1% (72/79)

PPV, positive predictive value; *NPV*, negative predictive value

modality, and used size criteria alone. As a result, we revealed that CT has a high diagnostic power for LPLN metastasis.

The reason our assessment with CT had a high accuracy is considered to be because of the contribution of PACS in improving the diagnostic power. We were able to examine LPLN with magnified images and change the contrast too easily in order to identify necessary features. Moreover, sequential pictures of thin slices facilitate the distinction of vessels.

CT is more widely used than MRI in OECD countries with a mean of 132 vs. 46 exams per 1000 population performed (doi: https://doi.org/10.1787/health_glance-2011-en). A disadvantage of CT is the inevitable radiation exposure; however, it takes less time to complete the scan and is able to provide images with less motion artifact because of the rapid imaging speed. Moreover, CT usually costs less than MRI, and patients with metal implants can undergo CT.

As mentioned earlier, LPLD is a standard procedure for T3-T4 lower rectal cancer in Japan. A retrospective multicenter study demonstrated that LPLD reduced approximately 50% of pelvic recurrences and improved 5-year overall survival [21]. However, LPLD has several disadvantages. In the JCOG 0212 trial, LPLD did not significantly increase postoperative complications but was accompanied by a longer operation time and a larger amount of bleeding [8]. Although LPLD with an autonomic nerve preservation may have been performed, genitourinary dysfunction may occur in 10–30% of patients [9]. At any rate, it cannot be denied that LPLD is an invasive procedure for patients. Therefore, it is important to reconsider the adaptation of LPLD on the basis of the guidelines, patient's choice, and background to avoid unnecessary LPLD. The result of our study will be helpful in deciding a treatment course in appropriate patients.

Conclusion

The result of this study suggests that CT with PACS has a good diagnostic capability. The long- and short-axis diameters were both useful indicators of LPLN metastasis. The cut-off values of metastatic LPLN were 7.6 mm for the long-axis diameter and 5.5 mm for the short-axis diameter.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

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