Usefulness of ^{18}F -FDG PET/CT to Detect Metastatic Mucinous Adenocarcinoma Within an Inguinal Hernia

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Abstract Metastatic mucinous adenocarcinoma in an inguinal hernia is a rare disease and the image findings of ^{18}F -fluorodeoxyglucose (^{18}F -FDG) positron emission tomography (PET)/computed tomography (CT) are little known. Here, we introduce a 57-year-old man with metastatic mucinous adenocarcinoma in an inguinal hernia. On initial ^{18}F -FDG PET/CT, hypermetabolism was observed in mucinous adenocarcinoma of the cecum, and adenocarcinomas of the transverse and ascending colon, respectively. Follow-up ^{18}F -FDG PET/CT revealed newly developed multiple hypermetabolism in peritoneal seeding masses and nodules in the pelvic cavity and scrotum. Peritoneal carcinomatosis in the right pelvic side wall was extended to the incarcerated peritoneum and mesentery in the right inguinoscrotal hernia. ^{18}F -FDG PET/CT was useful to reveal unexpected peritoneal seeding within the inguinal hernia. Also, this case demonstrated that metastatic mucinous adenocarcinomas had variably intense FDG uptake.

Keywords Metastatic mucinous adenocarcinoma · Inguinal hernia · ^{18}F -FDG PET/CT · Colorectal cancer

Introduction

An inguinal hernia is a common disease with a prevalence of 4 % for those aged over 45 years [1]. The symptom of an inguinal hernia is mostly mild and a third of patients have no pain [2]. Severe complication such as strangulation is uncommon. A randomized clinical trial mentioned that watchful waiting is an acceptable option for men with minimally symptomatic inguinal hernias [3]. Therefore, asymptomatic inguinal hernia might be negligible in the clinic.

^{18}F -fluorodeoxyglucose (^{18}F -FDG) positron emission tomography (PET)/computed tomography (CT) is an established modality to evaluate colorectal cancer. The findings of preoperative or postoperative ^{18}F -FDG PET/CT can influence staging and treatment [4]. Further, ^{18}F -FDG PET/CT has a significant role in the management and outcome for patients with recurrence colorectal cancer [5]. Moreover, quantitative methods including standardized uptake value [6] and volumetric parameters of PET/CT [7] are useful to predict prognosis for colorectal cancer. Also, whole-body or torso PET/CT can detect unexpected metastasis as a one-step method.

The findings of ^{18}F -FDG PET/CT of mucinous adenocarcinoma has not been fully understood. Mostly, a mucinous component causes a result of low FDG uptake [8]. It has been reported that the intensity of FDG uptake was positively correlated with the tumor cellularity but negatively correlated with the amount of mucin. Therefore, the sensitivity of the FDG PET image for detecting mucinous adenocarcinoma was significantly lower than for detecting non-mucinous adenocarcinoma [9, 10]. However, a report mentioned that increased FDG uptake in mucinous adenocarcinoma was correlated with the pathological invasive area [11] and another report found that FDG uptake was a prognostic factor in mucinous carcinoma with marginal significance [12].

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An inguinal hernia is an uncommon site of metastasis. A previous report mentioned that only 0.07 % showed metastasis within their hernia [13]. Here, we report a case of metastasis within an inguinal hernia and the usefulness of ^{18}F -FDG PET/CT.

Case Report

A 57-year-old man had regular check-ups by his primary care doctor to manage an old intracranial hemorrhage, right inguinal hernia and multiple polypoid lesions in the stomach and colon. He was referred to our hospital for an operation on a polypoid lesion in the cecum. Colonoscopy for the biopsy was performed in our hospital. The biopsy confirmed a well-differentiated adenocarcinoma in cecum. On ^{18}F -FDG PET/CT for staging, biopsy confirmed cecal cancer, which showed intense uptake (Figs. 1a, b). Two other intense uptake lesions in the transverse colon and descending colon were suspicious for synchronous tumors. But, other multiple polypoid lesions, including in the descending colon, were adenomas with low- or high-grade dysplasia. Therefore, the patient had the right hemicolectomy initially. Cecal cancer was mucinous adenocarcinoma on the final pathologic report and it penetrated to the surface of the visceral peritoneum (pT4a). There was no lymph node metastasis. The results of immunohistochemical staining for tumor cells showed high MLH1 expression,

high MSH2 expression, EGFR negative, E-cadherin positive, Ki-67 labeling index 60–70 %, and p53 60–70 % positive. Another polypoid mass in transverse colon was adenocarcinoma with moderate differentiation and the depth of invasion was the neck of polyp (pT1). The hypermetabolic mass was slightly enlarged on follow-up contrast-enhanced abdomen CT. A second operation of snare polypectomy was done to remove a mass in descending colon, which was 10 months after right hemicolectomy. The pathologic report revealed intramucosal adenocarcinoma with invasion of lamina propria (pTis).

Initially, the levels of CA 19–9 and CEA were 54.4 U/mL and 2.3 ng/mL. During follow-up, the level of CEA was not elevated. However, the level of CA 19–9 was markedly increased (175.7 U/mL) after 20 months of right hemicolectomy (13.0 U/mL). The size of right inguinal hernia was $7.8 \times 7.1 \times 9.7$ cm initially (Fig. 2). During follow-up, the size of right inguinal hernia was slightly enlarged ($9.7 \times 6.9 \times 9.7$ cm). However, the patient had no symptom. Contrast-enhanced CT of the abdomen was performed and newly developed enlarged lymph nodes were detected in the pelvic cavity. ^{18}F -FDG PET/CT was performed to evaluate systemic metastasis (Figs. 1c, b, e and 3. Multiple hypermetabolic nodules in the pelvic cavity were suggestive of metastases. Moreover, hypermetabolic multiple masses and nodules within the right inguinal hernia were detected unexpectedly. Nodulectomy and partial omentectomy were performed. And reduction of hernia

Fig. 1 ^{18}F -FDG PET/CT to evaluate colon cancer and recurrence. **a** Initial ^{18}F -FDG PET/CT was performed to evaluate colorectal cancer. Maximized intensity projection image showed intense uptake in the cecum (SUVmax=10.6), ileum (SUVmax=6.2), and descending colon (SUVmax=6.0). There was no significant uptake in the scrotum. **b** Axial PET (upper panel), fusion PET/CT (middle panel) and CT (lower panel) showed intense uptake in the multiple colon cancer. **c** Twenty-two months later, follow-up ^{18}F -FDG PET/CT was performed to evaluate recurrence. Maximized intensity projection image showed newly developed multiple

peritoneal seeding masses and nodules in the pelvic cavity, left external iliac area, and right inguinal hernia. Multifocal hypermetabolism was observed in the inguinal hernia of the scrotum. **d** Fusion axial PET/CT showed increased uptake in the peritoneal seeding mass (yellow arrow, SUVmax=3.9). **e** Increased uptake of seeding nodule (SUVmax=3.2) in the left external iliac area was observed (blue arrow). We could observe the metastasized route of the herniated peritoneal fat (red arrow), which showed multiple nodularity with mild FDG uptake

Fig. 2 The inguinal hernia evaluated by the initial ^{18}F -FDG PET/CT. **a** MIP, **b** PET axial (*left*) and fusion axial PET/CT (*right*) showed physiologic uptake in the skin of right scrotum. Peritoneal fat in the right inguinal hernia showed no significant uptake. There was no evidence of metastasis. **c** Coronal PET (*left*) and fusion coronal PET/CT (*right*) showed physiologic uptake in the right testicle. And there was no significant uptake along the herniated peritoneal fat. Red arrow points to the right inguinal hernia

Fig. 3 Multiple peritoneal seeding nodules and mass in the right inguinal hernia on follow-up ^{18}F -FDG PET/CT. Hypermetabolic seeding nodules and mass are pointed out by arrows of different colors, respectively. **a** MIP **b** Axial PET (*left*) and fusion axial PET/CT (*right*) showed a 2.7-cm peritoneal seeding nodule with intense FDG uptake ($\text{SUV}_{\text{max}}=5.0$) indicated by the red arrow. **c** Coronal PET (*left*) and fusion coronal PET/CT (*right*) showed a 2.7-cm peritoneal seeding nodule on the upper level of the right inguinal hernia. **d** Axial PET (*left*) and fusion axial PET/CT in the mid-level of the right inguinal hernia showed a 1.6-

cm peritoneal seeding nodule with intense FDG uptake ($\text{SUV}_{\text{max}}=4.9$) indicated by the yellow arrow. Irregular uptake along the herniated peritoneal fat and multifocal uptake in the scrotum were the evidence of peritoneal seeding. Haziness and diffuse uptake along the herniated peritoneal fat were also metastatic mucinous adenocarcinoma. **e** Coronal PET (*left*) and fusion coronal PET/CT (*right*) showed a 1.6-cm seeding nodule (yellow arrow) and 5 cm mass (blue arrow) with hypermetabolism. The SUV_{max} of the 5-cm seeding mass was 3.6

and herniorrhaphy were co-operated. The omentum was incarcerated into the internal opening of right inguinal indirect hernia. Multiple whitish nodules and masses in the incarcerated omentum were observed. The largest mass was about 5 cm (Fig. 4). The peritoneal carcinomatosis was directly extended to the inguinal hernia. Three nodules in the right lateral pelvic wall were removed and a nodule in mesorectum was suspicious for direct rectal invasion. Therefore, low anterior resection was performed. All peritoneal seedings were confirmed by metastatic mucinous adenocarcinoma from cecum on histopathology.

Discussion

In this study, we observed moderate or intense FDG uptake in the multiple peritoneal seeding masses and nodules from mucinous adenocarcinoma on ^{18}F -FDG PET/CT. And the peritoneal carcinomatosis was extended to the incarcerated peritoneum and mesentery in the right inguinoscrotal hernia. Contrary to the previous reports that a mucinous component showed low FDG uptake, our report revealed that the primary mucinous adenocarcinoma showed intense FDG uptake ($\text{SUV}_{\text{max}}=10.6$) and multiple peritoneal seeding showed increased FDG uptake (SUV_{max} range, 2.7–5.0) similarly.

Metastatic cancer found within the hernia sac contents is a rare clinical manifestation. The tumor condition in relation to the hernial sac is classified as intrasaccular, saccular or extrasaccular. Intrasaccular tumor is the primary tumor of the herniated viscera. Saccular tumors involve the metastasis from peritoneal infiltration. Peritoneal carcinomatosis is the most common cause of saccular neoplasms in a previous report [14]. Also, several studies mentioned few neoplasms within an inguinal hernia. For example, a patient with undetectable serum prostate specific antigen level showed metastatic prostatic adenocarcinoma in an inguinal hernia [15]. Also, recurrence of gastrointestinal stromal tumors presented in an incarcerated inguinal hernia [16]. A patient with unexplained

iron deficiency anemia and asymptomatic inguinal hernia had intrasaccular herniated cecal adenocarcinoma [17]. Therefore, asymptomatic inguinal hernia had been underestimated by patients with gastrointestinal malignancy or intraperitoneal cancer.

Mucinous adenocarcinoma in colorectal cancer accounts for 11–12 %. Though the prognostic value of mucinous adenocarcinoma has been controversial, it is diagnosed in more advanced tumor stages [18]. Mucinous adenocarcinoma is defined by more than 50 % of the tumor volume composed of extracellular mucin [19]. It demonstrated poorer survival than adenocarcinoma or adenocarcinoma with a mucinous component [20]. Also, mucinous differentiation has been reported to be significantly related to mismatch repair protein deficiency [21]. The studied patient had an advanced stage of multiple synchronous colon cancer with intense FDG uptake. Moreover, both mucinous adenocarcinoma and adenocarcinoma co-existed, and MLH1 and MSH2 were highly expressed. Peritoneal seeding also showed increased uptake on follow-up ^{18}F -FDG PET/CT. Of mucinous adenocarcinoma from lung cancer, increased FDG uptake was associated with a larger invasive area [11]. Considering FDG uptake in gastric cancer with a mucinous component was a prognostic factor with marginal significance [12], the studied patient showed advanced staging (T4a) and later peritoneal seeding was widely extended along the mesentery and peritoneum. Therefore, we speculated that the large invasion and large size of peritoneal seeding caused variably intense FDG uptake. And the results implicated that this patient might be expected to have a more aggressive prognosis. However, the clinical significance of quantitative or volumetric parameters of ^{18}F -FDG PET/CT (tumor glycolysis, metabolic tumor volume, SUV_{max} , SUV_{mean} , etc.) has been little known in mucinous adenocarcinoma of colorectal cancer. A further larger population study correlated with pathology is needed.

^{18}F -FDG PET/CT was useful to detect unexpected metastasis within an inguinal hernia. Close follow-up and

Fig. 4 Gross photographic and microscopic images. **a** Gross photograph of multiple mucinous adenocarcinoma of the inguinal hernia. Multiple peritoneal seeding masses and nodules were observed. The largest one was 5 cm. **b** Microscopic image ($\times 100$) demonstrated metastatic

mucinous adenocarcinoma. Abundant extracellular mucin consisted of more than 50 %. Large glandular structures with pools of extracellular mucin were well manifested

examination of a hernia sac is recommended for a male patient who has previously undergone surgery for colorectal cancer and is advanced in age with an inguinal hernia. Also, our report demonstrated increased FDG uptake of metastatic mucinous adenocarcinoma contrary to previous reports.

Compliance with Ethical Standards

Conflict of Interest Hyo Jung Seo, Jae Seon Eo, Byung Wook Min, Sun Il Lee, Sang Hee Kang, Sung Yup Jung, Sang Chul Oh and Jae Gol Choe declare that they have no conflict of interest.

Ethical Statement All procedures performed in this study involving human participant were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The patient gave his informed consent prior to his inclusion in the study.

References

- Kingsnorth A, LeBlanc K. Hernias: inguinal and incisional. *Lancet*. 2003;362:1561–71.
- Page B, Paterson C, Young D, O'Dwyer PJ. Pain from primary inguinal hernia and the effect of repair on pain. *Br J Surg*. 2002;89:1315–8.
- Fitzgibbons RJ, Giobbie-Hurder A, Gibbs JO, et al. Watchful waiting vs repair of inguinal hernia in minimally symptomatic men: a randomized clinical trial. *JAMA*. 2006;295:285–92.
- Wasserberg N, Purim O, Bard V, Kundel Y, Gordon N, Groshar D, et al. Early postoperative F-18-FDG PET/CT in high-risk stage III colorectal cancer. *Clin Nucl Med*. 2015;40:E222–7.
- Tural D, Selcukbiricik F, Sager S, Akar E, Yildiz O, Serdengeci S. PET-CT changes the management and improves outcome in patients with recurrent colorectal cancer. *J Cancer Res Ther*. 2014;10:121–6.
- Byun BH, Moon SM, Shin US, Lim I, Kim BI, Choi CW, et al. Prognostic value of (18) F-FDG uptake by regional lymph nodes on pretreatment PET/CT in patients with resectable colorectal cancer. *Eur J Nucl Med Mol Imaging*. 2014;41:2203–11.
- Ogawa S, Itabashi M, Kondo C, Momose M, Sakai S, Kameoka S. Prognostic value of total lesion glycolysis measured by F-18-FDG-PET/CT in patients with colorectal cancer. *Anticancer Res*. 2015;35:3495–500.
- Chang JM, Lee HJ, Lee HY, Lee JJ, Chung JK, Im JG. False positive and false negative FDG-PET scans in various thoracic diseases. *Korean J Radiol*. 2006;7:57–69.
- Berger KL, Nicholson SA, Dehdashti F, Siegel BA. FDG PET evaluation of mucinous neoplasms: correlation of FDG uptake with histopathologic features. *AJR Am J Roentgenol*. 2000;174:1005–8.
- Huang S, Sun C, Li X, Guan J, Feng S, Peng Z, et al. Comprehensive application of CT and PET/CT in diagnosing colorectal mucinous and non-mucinous adenocarcinoma. *Zhonghua Wei Chang Wai Ke Za Zhi*. 2014;17:230–4.
- Murakami S, Saito H, Karino F, Kondo T, Oshita F, Ito H, et al. ¹⁸F-fluorodeoxyglucose uptake on positron emission tomography in mucinous adenocarcinoma. *Eur J Radiol*. 2013;82:e721–5.
- Lee JW, Lee SM, Lee MS, Shin HC. Role of (1)(8)F-FDG PET/CT in the prediction of gastric cancer recurrence after curative surgical resection. *Eur J Nucl Med Mol Imaging*. 2012;39:1425–34.
- Nicholson CP, Donohue JH, Thompson GB, Lewis JE. A study of metastatic cancer found during inguinal hernia repair. *Cancer*. 1992;69:3008–11.
- Matsumoto G, Ise H, Inoue H, Ogawa H, Suzuki N, Matsuno S. Metastatic colon carcinoma found within an inguinal hernia sac: report of a case. *Surg Today*. 2000;30:74–7.
- Chung SD, Yu HJ, Lin WC, Huang KH. Metastatic prostatic adenocarcinoma in an inguinal hernia sac in a patient with undetectable serum prostate specific antigen level. *J Formos Med Assoc*. 2007;106:397–9.
- Liu P-H, Kung W-C, Wu Y-C, Chien S-T, Chang W-Y, Hsu C-W. Metastatic malignant gastrointestinal stromal tumor mimicking a right incarcerated inguinal hernia. *Formos J Surg*. 2014;47:189–92.
- Marsden M, Curtis N, McGee S, Bracey E, Branag G, Sleight A. Intrascrotal caecal adenocarcinoma presenting as enlarging right inguinoscrotal hernia. *Int J Surg Case Rep*. 2014;5.
- Langner C, Harbaum L, Pollheimer MJ, Komprat P, Lindtner RA, Schlemmer A, et al. Mucinous differentiation in colorectal cancer—indicator of poor prognosis? *Histopathology*. 2012;60:1060–72.
- Bosman FT, World Health Organization, International Agency for Research on Cancer. WHO classification of tumours of the digestive system. 4th ed. World Health Organization classification of tumours, vol 3. International Agency for Research on Cancer: Lyon; 2010.
- Foda AAM, El-Hawary AK, Aziz AA. Colorectal adenocarcinoma with mucinous component: relation of MMP-13, EGFR, and E-cadherin expressions to clinicopathological features and prognosis. *APMIS*. 2015;123:502–8.
- Nitsche U, Zimmermann A, Spath C, Muller T, Maak M, Schuster T, et al. Mucinous and signet-ring cell colorectal cancers differ from classical adenocarcinomas in tumor biology and prognosis. *Ann Surg*. 2013;258:775–82. discussion 82–3.