

Restaging of colorectal cancer and PET/CT

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ABSTRACT

Positron Emission Tomography/Computerized Tomography (PET/CT) is an important assessment method in restaging of oncology patients. Its ability to detect the metabolic/functional changes in patients with colorectal cancer during the early stages, in which morphological changes cannot be documented, is significantly superior to other imaging modalities.

Key Words: Colorectal cancer, restaging, PET-CT

INTRODUCTION

Colorectal cancer recurrence usually develops in the first 4 years following surgery and mostly presents with hepatic involvement (33%). While Positron Emission Tomography gathers information on the body's metabolic / functional activity, concurrent CT provides anatomical details of normal and pathological tissues in the body. The superiority of PET/CT to other radiologic methods is its ability to demonstrate metabolic/functional changes in tumor tissues at an early stage where morphological changes have not yet occurred. With this method, early detection of tumor tissue, early treatment planning, and thus prolongation of survival is possible.

Colorectal Cancer

In our country, the incidence of colorectal cancer is reported as 18.2/100 000 in men and as 12, 1/100 000 in women (1-5). Age is an important factor in the incidence of colorectal cancer. Sporadic colorectal cancer incidence significantly increases over the age of 45-50 (6). Thirty percent of colorectal cancer tumors are located in the rectum, 28% in the sigmoid, 9% in the descending colon, 11% in the transverse colon, 9% in the ascending colon, and 13% in the cecum (6). 3 to 6% of colorectal carcinomas are multicentric (7-9). Local invasion of the tumor into deeper tissues lead to peritoneal metastasis, whereas its spread through vascular structures and regional drainage lead to liver, lung and bone marrow metastasis. Rectal cancer can spread to adjacent structures such as adjacent adipose tissue, vagina, prostate, bladder, ureter and the bony pelvis (10-15).

Restaging of Colorectal Cancer

Recurrence in rectal cancer differs from those of other parts of the colon. Local recurrence in rectal cancer (7-33%) occurs at a higher rate as compared to colon cancer (1-19%). Sites of distant metastasis relies on the venous drainage of the primary site; venous drainage of the colon and upper part of rectum is into the liver through the portal vein therefore causing liver metastases, whereas the lower part of the rectum has a dual drainage, isolated pulmonary metastases without liver metastases can be observed. Orband and Gordon, in their recurrence analysis of 146 patients with colorectal cancer, reported 46% local, 52% local and distant recurrence rates. In studies, it has been shown that 20% patients with recurrence have isolated hepatic metastases, and if untreated 5-year survival rate of these patients is 28% (16-23).

Positron Emission Tomography (PET)

A PET/CT scan begins with detection of scanning area with an explorative CT, continues with helical CT scan, and is completed by PET scan. Positron emission tomography/CT does not contain fused images, the PET and CT images are always separated. Merging the two images together is the process of placing images over each other rather than creating a new image. In positron emission tomography imaging for oncological applications, the most preferred method is to follow glucose metabolism. For this purpose, an 18F radioisotope fluorodeoxyglucose (18F-FDG) is being used. Because it is not a specific agent for

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cancer, its uptake can also be detected at the sites of infection and inflammation but in malignant lesions the retention continues even in the late periods in contrast to benign pathologies (24-28).

PET in Colorectal Cancer

It has been reported that positron emission tomography/CT changed staging in 31% of patients who underwent conventional imaging. The altered staging has changed the planned treatment in 8% of cases. The sensitivity and specificity of PET / CT and CT in detecting tumors is reported as 98.1% and 66.7% ($p < 0.0001$), 75% and 62.5% ($p = 0.056$), respectively (29). Imaging with FDG in patients with colorectal cancer is accepted as an effective method that could lead to changes in patient treatment. Early detection of liver metastases allows the opportunity of neoadjuvant chemotherapy and resection in colorectal cancer patients, with a possible increase in survival. In a meta-analysis comparing the effectiveness of CT, MR and PET/CT for the detection of liver metastasis of colorectal cancer, the sensitivity of imaging methods were determined as 83.6%, 88.2% and 94.1%, respectively (30-32). The most important effect of positron emission tomography/CT imaging is the ability of detecting extra-hepatic metastases that prevent surgical treatment in colorectal cancer patients with liver metastases. In 11-32% of patients with liver metastases who were planned for surgery, PET detected extra-hepatic metastases. This situation leads to a change in treatment to a more systemic route by including chemotherapy (33-35). However, PET has limitations due to false-positive results in the context of size and inflammation. In addition, since cystic tumors or mucinous lymph node metastases do not show a significant FDG uptake, FDG PET images is not reliable in ruling out lymph node metastasis of colorectal cancer (Figure 1, 2).

The lung is another target organ other than the liver for spread of colorectal cancer. Pulmonary involvement of lymph nodes and pleural involvement are findings of metastatic disease. Approximately 10% of colorectal cancer patients develop pulmonary metastases. In 2-4% of patients it is seen as isolated pulmonary metastases and surgery can be applied in about half of them. After successful surgery, the 5-year survival rate ranges from 28% to 40% (36-39). The sensitivity and specificity of positron emission tomography/CT in the detection of malignant solitary pulmonary lymph nodules have been reported as 96% and 83%, respectively. Positron Emission Tomography/CT's CT component is the most sensitive method for the detection of pulmonary metastases, whereas FDG PET images provide additional specificity in lymph nodes larger than 8 mm (36). A negative finding in Positron Emission Tomography/CT scan does not rule out the presence of pulmonary metastases due to the limited spatial resolution, still it confirms suspicious findings observed on CT.

Bone metastases in colorectal cancer have been rarely reported. In a study of 5000 patients, bone metastasis with visceral metastases is reported as 6.6%, and isolated bone metastasis as 1.1% (38). Studies reported that PET/CT is both sensitive and specific in the diagnosis of malignant bone metastases. In another study bone metastasis was detected in 59 out of 712 patients with PET/CT examination, with a positive predictive

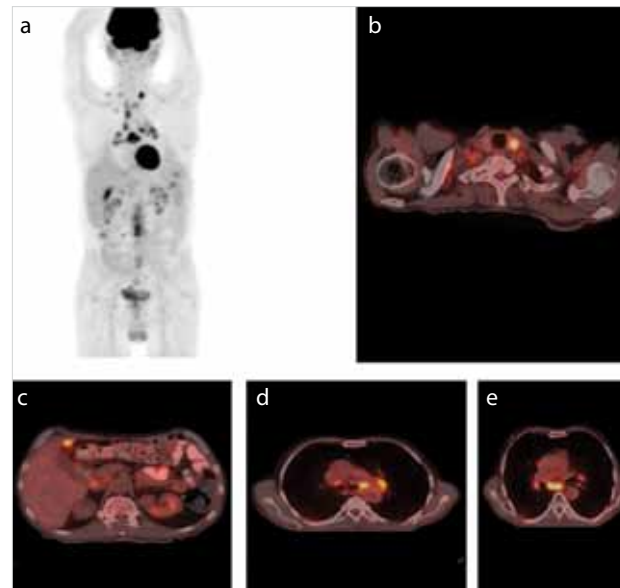


Figure 1. PET/CT for re-staging; 6 years old male, colon cancer a) Total body PET view b) Slightly increased FDG uptake in the neck adjacent to the left thyroid lobe c) Subcapsular metastatic foci in Segment 2 and 10x9 mm lymph node in the right para-caval region d) Left paraoesophageal and aortopulmonary lymph nodes e) 14x9 mm lymph node right lateral to the ascending aorta

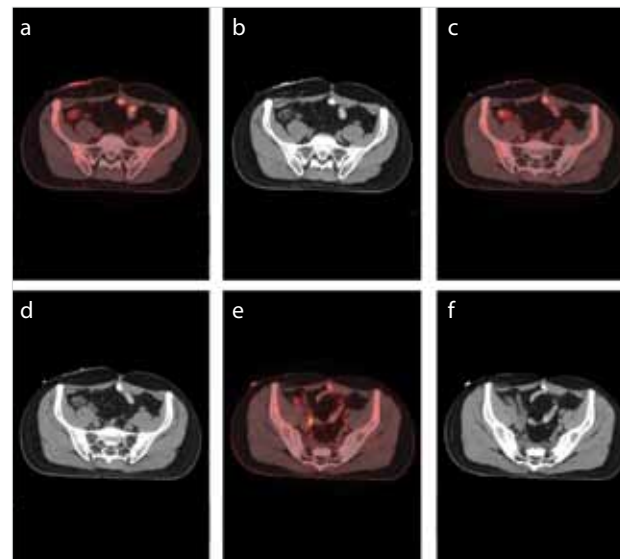


Figure 2. Re-staging PET/CT; 98 years-old male, rectal carcinoma. a,b,c,d) Peritoneal implants posterior to the anterior abdominal wall at the pelvic level e,f) Rectosigmoid mass, presacral 12 mm lesion at the operation field

value of 98% (37-39). Distinction of scar tissue from surgery, radiation or recurrence scar is important in patients with previous colon cancer, this is a particular problem for distal colon and rectal cancer where pre-sacral and pelvic scarring changes are common. The PET/CT performed at the postoperative 6th month is superior to CT or MRI alone in the differentiation of malignant and benign pre-sacral changes. Currently PET/CT scan is accepted as the imaging method of choice, with its ability to detect disease at once, to show its localization and to guide diagnosis and treatment in such patients.

DISCUSSION

In our country when the results of a survey conducted by the Ministry of Health are evaluated; colorectal cancer ranks third after lung and breast cancer. The incidence is reported as 7.7%; the distribution as 59% male, 41% female and the male/female ratio as 1.44. For this type of cancer diagnosis age was 62 years (1).

A study conducted by Willkomm et al. (40) reported relapse within 3 years after resection of the primary tumor. Early diagnosis and treatment of recurrent disease increases quality of life, diagnosis of potentially resectable metastases or recurrence improves prognosis (41). Surgical resection can be performed in 12-60% of patients with proven tumor recurrence. The expected life span is at least 80-month in approximately half of these patients. Asymptomatic tumor recurrence is important even though surgical resection cannot be performed. Systemic treatment regimens are more effective than symptomatic treatment. Scott et al. (42) conducted a study in 10 patients with elevated serum tumor marker (CEA) levels, and identified recurrence with PET in 8 of them. Haseman et al. (43) used radioimmunosintigraphy as an alternative approach under same clinical circumstances in 140 patients, and reported sensitivity as 79%, and specificity as 84%. Morales - Gutierrez et al. (44) have shown that CA 19, 9elevations during patient follow-up is an independent risk factor for relapse and that patients with these high values have poor prognosis. Willkomm et al. (40) compared FDG-PET and CEA 123 scans for detection of recurrence, and they reported sensitivity and specificity of CEA -scan as 89% and 100% , and of FDG PET as 100% and 95% , respectively. So far, imaging modalities have been compared in terms of accuracy in identification of colorectal recurrence and metastasis. The sensitivity and specificity of fluorodeoxyglucose PET in the detection of colorectal cancer recurrence and metastasis is higher as compared to CT and MR. With fluorodeoxyglucose PET distinction between tumor and scar tissue could be made. The false-positive findings on FDG PET can be explained by inability of complete analysis of especially the dorsal pelvic region in the studied patient groups due to; FDG's being a nonspecific agent, accumulation in foci of inflammation, renal elimination and formation of artifact around the kidney and bladder after image reconstruction (45-49). Because fluorodeoxyglucose is expensive the CEA -scan was tested as an alternative; sensitivity, specificity and accuracy rates of CEA- scan were reported as 89%, 100% and 96%, while the same values for FDG PET were stated as 100%, 95% and 96%, respectively (45, 46).

In studies regarding tumor location, the sensitivity of FDG-PET in determining liver metastases was reported as 91% with a specificity of 100%, whereas the sensitivity of CT was 74% and specificity was 85% (47). Locoregional pelvic recurrence and liver metastasis are reported as the most frequently relapsing sites. Despite all advanced scanning methods and advanced treatment modalities, approximately 40% of patients with a diagnosis of primary colorectal cancer will develop liver metastases. 25 to 50% of patients who died of cancer have liver metastases. The positive effects of systemic chemotherapy on survival have not been shown. Besides systemic chemotherapy, selective chemoembolization, radiofrequency abla-

tion, cryoablation, alcohol ablation, radiolabelled Yttrium 90 microspheres are also used in regional therapy. PET results for the evaluation of the results of therapeutic response after application of radiolabelled Yttrium 90 microspheres for liver metastases have been reported to have a better correlation than CT, MRI, or tumor marker changes. The importance of PET/CT scan in patient selection and evaluation of treatment response to this promising first line treatment for unresectable liver metastasis is highlighted in many publications.

Anastomotic recurrence can be detected in 2-4%, with a 10 times higher likelihood in rectal cancer (5). Due to physiological and post-surgical factors FDG uptake is increased, the specificity is low for anastomotic recurrence. Presacral abscess and inflammatory scar tissue are potential sources of false-positive results with PET/CT.

CONCLUSION

The shift in PET technology towards PET/CT providing anatomical and metabolic images, and its importance in determining clinical approach to colorectal cancer is emphasized. PET/CT is often used for detection of recurrence and/or metastasis in case of elevated tumor markers with unexplained etiology, patient selection for surgery, the decision to start treatment and choice of treatment, and evaluation of post-treatment response. Although the wide utilization of PET/CT scan increases the cost, it provides significant advantages in the treatment of colorectal cancer, as in many other cancer types if used with the correct indications.

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REFERENCES

1. Kalaycı G. Colon cancer, Genel Cerrahi, Nobel Tıp Kitabevi İstanbul 2002: 1343-1359.
2. Topuz E, Aykan FN. Gastrointestinal System Tumors. İstanbul Üniversitesi Onkoloji Enstitü Yayınları 1998: 373-475.
3. Fenoglio-Preiser CM, Noffsinger AE. Other Tumours of the Large Intestine. In: Gastrointestinal and Oesophageal Pathology, ed. Whitehead R, Churchill Livingstone, New York 2nd ed., 1995: 863-905.
4. Rosai J. Large Bowel. In: Ackerman's Surgical Pathology, ed. Rosai J. St Louis, 8th ed., Mosby, 1996: 729-799.
5. Winawer SJ, Zauber AG, Gerdes H, O'Brien MJ, Gottlieb LS, Sternberg SS, et al. Risk of colorectal cancer in the families of patients with adenomatous polyps. N Engl J Med 1996; 334: 82-87. [CrossRef]
6. Cusack JC, Giacco GG, Cleary K, Davidson BS, Izzo F, Skibber J, et al. Survival factors in 186 patients younger than 40 years old with colorectal adenocarcinoma. J Am Coll Surg 1996; 183: 105-112.
7. Messerini L, Palomba A, Zampi G. Primary signet-ring cell carcinoma of the colon and rectum. Dis Colon Rectum 1995; 38: 1189-1192. [CrossRef]

8. de Bruïne AP, Wiggers T, Beek C, Volovics A, von Meyenfeldt M, Arends JW, et al. Endocrine cells in colorectal adenocarcinomas: incidence, hormone profile and prognostic relevance. *Int J Cancer* 1993; 54: 765-771. [\[CrossRef\]](#)
9. Kobayashi H, Mochizuki H, Kato T, Mori T, Kameoka S, Shirouzu K, et al. Lymph node ratio is a powerful prognostic index in patients with stage III distal rectal cancer: a Japanese multicenter study. *Int J Colorectal Dis* 2011; 26: 891-896. [\[CrossRef\]](#)
10. Greene F, Stewart A, Norton H. A new TNM staging strategy for node-positive (stage III) colon cancer: an analysis of 50,042 patients. *Ann Surg* 2002; 236: 416-421. [\[CrossRef\]](#)
11. Wong JH, Severino R, Honnebler MB, Tom P, Namiki TS. Number of nodes examined and staging accuracy in colorectal carcinoma. *J Clin Oncol* 1999; 17: 2896-2900.
12. Wiering B, Krabbe PF, Jager GJ, Oyen WJ, Ruers TJ. The impact of fluor-18-dexyglucose-positron emission tomography in the management of colorectal liver metastases: A systematic review and metaanalysis. *Cancer* 2005; 104: 2658-2670. [\[CrossRef\]](#)
13. Potter KC, Husband JE, Houghton SL, Thomas K, Brown G. Diagnostic accuracy of serial CT/magnetic resonance imaging review vs. positron emission tomography/CT in colorectal cancer patients with suspected and known recurrence. *Dis Colon Rectum* 2009; 52: 253-259. [\[CrossRef\]](#)
14. Graham RA, Wang S, Catalano PJ, Haller DG. Postsurgical surveillance of colon cancer: preliminary cost analysis of physician examination, carcinoembryonic antigen testing, chest x-ray, and colonoscopy. *Ann Surg* 1998; 228: 59-63. [\[CrossRef\]](#)
15. Even-Sapir E, Metsler U, Flusser G, Zuriel L, Kollender Y, Lerman H. Assessment of malignant skeletal disease: initial experience with 18F-fluoride PET/CT and comparison between 18F-fluoride PET and 18F-fluoride PET/CT. *J Nucl Med* 2004; 45: 272-278.
16. Turk PS, Wanebo HJ. Results of surgical treatment of nonhepatic recurrence of colorectal carcinoma. *Cancer* 1993; 71: 4267-4277. [\[CrossRef\]](#)
17. Willett C, Tepper JE, Cohen A, Orlow E, Welch C, Donaldson G. Local failure following curative resection of colonic adenocarcinoma. *Int J Radiat Oncol Biol Phys* 1984; 10: 645-651. [\[CrossRef\]](#)
18. Pilipshen SJ, Heilweil M, Quan SH, Sternberg SS, Enker WE. Patterns of pelvic recurrence following definitive resections of rectal cancer. *Cancer* 1984; 53: 1354-1362. [\[CrossRef\]](#)
19. Obrand DI, Gordon PH. Incidence and patterns of recurrence following curative resection for colorectal carcinoma. *Dis Colon Rectum* 1997; 40: 15-24. [\[CrossRef\]](#)
20. Brethauer SA, Magrino TJ, Riffenburgh RH, Johnstone PA. Management of recurrent colorectal carcinoma. *Colorectal Dis* 2002; 4: 246-253. [\[CrossRef\]](#)
21. Dawson LE, Russell AH, Tong D, Wisbeck WM. Adenocarcinoma of the sigmoid colon: sites of initial dissemination and clinical patterns of recurrence following surgery alone. *J Surg Oncol* 1983; 22: 95-99. [\[CrossRef\]](#)
22. Agress H Jr, Cooper BZ. Detection of clinically unexpected malignant and premalignant tumors with whole-body FDG PET: histopathologic comparison. *Radiology* 2004; 230: 417-422. [\[CrossRef\]](#)
23. Yasuda S, Fujii H, Nakahara T, Nishiumi N, Takahashi W, Ide M, et al. 18F-FDG PET detection of colonic adenomas. *J Nucl Med* 2001; 42: 989-992.
24. Pickhardt PJ, Choi JR, Hwang I, Butler JA, Puckett ML, Hildebrandt HA, et al. Computed tomographic virtual colonoscopy to screen for colorectal neoplasia in asymptomatic adults. *NEJM* 2003; 349: 2191-2200. [\[CrossRef\]](#)
25. Skibber JM, Minsky BD, Hoff PM. Spread of colorectal cancer. In: DeVita VT, Hellman S, Rosenberg SA (eds.). *Cancer: principles and practice of oncology*. 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2001: 1229-1230.
26. Abdel-Nabi H, Doerr RJ, Lamonica DM, Cronin VR, Galantowicz PJ, Carbone GM, et al. Staging of primary colorectal carcinomas with fluorine-18 fluorodeoxyglucose wholebody PET: correlation with histopathologic and CT findings. *Radiology* 1998; 206: 755-760.
27. Mukai M, Sadahiro S, Yasuda S, Ishida H, Tokunaga N, Tajima T, et al. Preoperative evaluation by whole-body 18F-fluorodeoxyglucose positron emission tomography in patients with primary colorectal cancer. *Oncol Rep* 2000; 7: 85-87.
28. Imdahl A, Reinhardt MJ, Nitzsche EU, Mix M, Dingeldey A, Einert A, et al. Impact of 18F-FDG positron emission tomography for decision making in colorectal cancer recurrences. *Langenbecks Arch Surg* 2000; 385: 129-134. [\[CrossRef\]](#)
29. Boykin KN, Zibari GB, Lilien DL, McMillan RW, Aultman DF, McDonald JC. The use of FDG-positron emission tomography for the evaluation of colorectal metastases of the liver. *Am Surg* 1999; 65: 1183-1185.
30. Fong Y, Saldinger PF, Akhurst T, Macapinlac H, Yeung H, Finn RD, et al. Utility of 18F-FDG positron emission tomography scanning on selection of patients for resection of hepatic colorectal metastases. *Am J Surg* 1999; 178: 282-287. [\[CrossRef\]](#)
31. Rohren EM, Paulson EK, Hagge R, Wong TZ, Killius J, Clavien PA, et al. The role of F-18 FDG positron emission tomography in preoperative assessment of the liver in patients being considered for curative resection of hepatic metastases from colorectal cancer. *Clin Nucl Med* 2002; 27: 550-555. [\[CrossRef\]](#)
32. Sahani DV, Kalva SP, Fischman AJ, Kadavigere R, Blake M, Hahn PF, et al. Detection of liver metastases from adenocarcinoma of the colon and pancreas: comparison of mangafodipir trisodium-enhanced liver MRI and whole-body FDG PET. *AJR Am J Roentgenol* 2005; 185: 239-246. [\[CrossRef\]](#)
33. Huebner RH, Park KC, Shepherd JE, Schwimmer J, Czernin J, Phelps ME, et al. A meta-analysis of the literature for whole-body FDG PET detection of recurrent colorectal cancer. *J Nucl Med* 2000; 41: 1177-1189.
34. Lai DT, Fulham M, Stephen MS, Chu KM, Solomon M, Thompson JF, et al. The role of whole-body positron emission tomography with [18F]fluorodeoxyglucose in identifying operable colorectal cancer metastases to the liver. *Arch Surg* 1996; 131: 703-707. [\[CrossRef\]](#)
35. Sternberg SS. Colon. In: *Histology for Pathologists*, ed Sternberg SS, Raven Press, New York, 1992: 573-588.
36. McCormack PM, Attiyeh FF. Resected pulmonary metastases from colorectal cancer. *Dis Colon Rectum* 1979; 22: 553-556. [\[CrossRef\]](#)
37. Goya T, Miyazawa N, Kondo H, Tsuchiya R, Naruke T, Suemasu K. Surgical resection of pulmonary metastases from colorectal cancer. 10-year follow-up. *Cancer* 1989; 64: 1418-1421. [\[CrossRef\]](#)
38. Even-Sapir E, Parag Y, Lerman H, Gutman M, Levine C, Rabau M, et al. Detection of recurrence in patients with rectal cancer: PET/CT after abdominoperineal or anterior resection. *Radiology* 2004; 232: 815-822. [\[CrossRef\]](#)
39. Flanagan FL, Dehdashti F, Ogunbiyi OA, Kodner IJ, Siegel BA. Utility of FDG-PET for Investigating Unexplained Plasma CEA Elevation in Patients With Colorectal Cancer. *Ann Surg* 1998; 227: 319-323. [\[CrossRef\]](#)
40. Willkomm P, Bender H, Bangard M, Decker P, Grünwald F, Biersack HJ. FDG PET and immunoscintigraphy with 99mTc-labeled antibody fragments for detection of the recurrence of colorectal carcinoma. *J Nucl Med* 2000; 41: 1657-1763.
41. Nozoe T, Rikimaru T, Mori E, Okuyama T, Takahashi I. Increase in both CEA and CA 19-9 in sera as Independent Prognostic Indicator in Colorectal Carcinoma. *J Surg Oncol* 2006; 94: 132-137. [\[CrossRef\]](#)
42. Scott AM, Macapinlac HA, Divgi CR, Zhang JJ, Kalaigian H, Pentlow K, et al. Clinical Validation of SPECT and CT/MRI Image Registration in Radiolabeled Monoclonal Antibody Studies of Colorectal Carcinoma. *J Nucl Med* 1994; 35:1976-1984.
43. Haseman MK, Brown DW, Keeling CA, Reed NL. Radioimmunodetection of occult carcinoembryonic antigen producing cancer. *J Nucl Med* 1992; 33: 1750-1757.
44. Morales-Gutiérrez C, Vegh I, Colina F, Gómez-Cámara A, Ignacio Landa J, Ballesteros D, et al. Survival of patients with colorectal carcinoma: possible prognostic value of tissular carbohydrate antigen 19.9 determination. *Cancer* 1999; 86: 1675-1681. [\[CrossRef\]](#)

45. Schlag P, Lehner B, Strauss LG, Georgi P, Herfarth C. Scar or recurrent rectal cancer. Positron emission tomography is more helpful for diagnosis than immunoscintigraphy. *Arch Surg* 1989; 124: 197-200. [\[CrossRef\]](#)
46. Lubezky N, Metser U, Geva R, Nakache R, Shmueli E, Klausner JM, et al. The role and limitations of 18-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) scan and computerized tomography (CT) in restaging patients with hepatic colorectal metastases following neoadjuvant chemotherapy: comparison with operative and pathological findings. *J Gastrointest Surg* 2007; 11: 472-478. [\[CrossRef\]](#)
47. Şen M, Turan M. Surgical approach to colorectal cancer with liver metastasis. *Cumhuriyet Tıp Derg* 2009; 31: 331-338.
48. Peynircioğlu B, Çil B, Bozkurt F, Aydemir E, Uğur Ö, Balkancı F. Radioembolization for unresectable liver cancer treatment. *Diag Interv Radiol* 2010; 16: 778.
49. Koca G, İlgan S, Kitapçı MT. Hydatid disease of the liver mimicking metastasis on FDG PET in a colon cancer patient. *Gülhane Med J* 2012; 54: 243-247.