PET/CT after Chemotherapy: Hepatic Metastases from Colorectal Cancer

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Nashville, TN

Tuesday June 17: 2:30-4:00 PM
Detection of Recurrent Colorectal Carcinoma

70% are resected with curative intent 1/3 have recurrence within 2 years.

25% have recurrence to one site and are potentially curable by surgical resection.

Conventional methods for detection of recurrence:

- CEA levels: Only ~2/3 of patients have elevated and it does not localize.
- CT: suboptimal for metastases in the peritoneum, mesentery, LN
- Differentiation of post-treatment changes from recurrence.
FDG PET for Detection of Recurrent Colorectal Cancer

Meta-Analysis: 11 studies and 577 patients analyzed on a patient-basis:
- Sensitivity: 97%
- Specificity: 75%
  - higher for local recurrence and hepatic metastases (>95%)
- Change of management was 29%.

Summary of the literature for evaluation of recurrence:
- Sensitivity: PET 94%, CT 79% (2244 patients studies)
- Specificity: PET 87%, CT 73% (2244 patients studies)
- Change in management: 32% (915 patients studies)

Gambhir SS et al. J Nucl Med 2001;42(suppl):9S-12S.
FDG PET for Detection of Hepatic Metastases from Colorectal Carcinoma

- 14,000 patients per year present with isolated liver metastases and 20% die with metastases exclusively to the liver.
  - Hepatic resection is the only curative therapy
    - mortality 2-7%, high morbidity
  - Number, size and extrahepatic metastases affect the prognosis

- Accurate non-invasive detection of inoperable disease plays a pivotal role in selecting patients who would benefit surgery.
FDG PET for Detection of Hepatic Metastases

- Meta-analysis comparing non-invasive methods
  - 111 data sets (1985-2000) of patients with colorectal or other GI cancer giving hypodense liver metastases

- Mean weighted sensitivity at a specificity of 85% or higher (patient-based):
  - US (509 patients): 55%
  - CT with contrast (1747 patients): 72%
  - MR (401 patients): 76%
  - FDG PET (423 patients): 90%

Kinkel K et al. Radiology 2002;224:748-756.
FDG PET for Detection of Colorectal Hepatic Metastases

- Meta-analysis comparing non-invasive methods
  - 61/165 data sets were included
- Sensitivity for detection of liver metastases:

<table>
<thead>
<tr>
<th></th>
<th>Patient</th>
<th>Lesion</th>
<th>Lesions &gt;1 cm</th>
</tr>
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<tbody>
<tr>
<td>CT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- non helical:</td>
<td>60%</td>
<td>52%</td>
<td>74%</td>
</tr>
<tr>
<td>- helical:</td>
<td>65%</td>
<td>64%</td>
<td>74%</td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MR no Gad</td>
<td>76%</td>
<td>66%</td>
<td>65%</td>
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<tr>
<td>MR Gad</td>
<td></td>
<td></td>
<td>69%</td>
</tr>
<tr>
<td>MR SPIO</td>
<td></td>
<td></td>
<td>90%</td>
</tr>
<tr>
<td>PET:</td>
<td>95%</td>
<td>76%</td>
<td></td>
</tr>
</tbody>
</table>

Comparison FDG PET/multiphase CT and intraoperative US for Detection of Hepatic Metastases

- 131 patients selected for hepatic resection of colorectal liver metastases: 363 liver metastases were identified

**Sensitivity for detection:**

- 63 lesions < 10 mm: CT 71%  
  PET 16%
- 172 lesions 10-20 mm: CT 72%  
  PET 75%
- 128 lesions > 20 mm: CT 97%  
  PET 95%
- All: CT 71%  
  PET 72%

- Both CT and PET missed ~ 30% smaller lesions resulting in change in management in 7% (9/131) patients

### FDG PET for Detection of Recurrent Colorectal Carcinoma

<table>
<thead>
<tr>
<th>Reference</th>
<th>No patients</th>
<th>Sites</th>
<th>PET Sens</th>
<th>PET Spec</th>
<th>CT Sens</th>
<th>CT Spec</th>
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<tbody>
<tr>
<td>Strauss 89</td>
<td>29</td>
<td>Local recur</td>
<td>95%</td>
<td>100%</td>
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<tr>
<td>Vitola 96</td>
<td>24</td>
<td>Liver</td>
<td>90%</td>
<td>100%</td>
<td>86%</td>
<td>58%</td>
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<tr>
<td>Delbeke 97</td>
<td>61</td>
<td>Liver</td>
<td>91%</td>
<td>92%</td>
<td>81%</td>
<td>78%</td>
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<tr>
<td></td>
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<td>92%</td>
<td>74%</td>
<td>71%</td>
</tr>
<tr>
<td>Ogunbiy 97</td>
<td></td>
<td>Local recur</td>
<td>91%</td>
<td>100%</td>
<td>52%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liver</td>
<td>95%</td>
<td>100%</td>
<td>52%</td>
<td>80%</td>
</tr>
<tr>
<td>Valk 99</td>
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<td>All sites</td>
<td>93%</td>
<td>79%</td>
<td>78%</td>
<td>50%</td>
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<tr>
<td>Whiteford</td>
<td>105</td>
<td>Mucinous +</td>
<td>92%</td>
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<td></td>
<td></td>
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<td></td>
<td>58%</td>
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<td>Zhuang 00</td>
<td>28</td>
<td>Liver</td>
<td>100%</td>
<td>100%</td>
<td>71%</td>
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<tr>
<td>Staib 00</td>
<td>100</td>
<td>All sites</td>
<td>98%</td>
<td>90%</td>
<td>91%</td>
<td>72%</td>
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<tr>
<td>Johnson 01</td>
<td>41</td>
<td>Liver</td>
<td>100%</td>
<td>69%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pelvis</td>
<td>87%</td>
<td>61%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity of FDG PET is ~ 90% and specificity > 70%, both > to CT.
Patient with metastatic mucinous colon carcinoma

From Delbeke D and Israel O. Hybrid PET/CT and SPECT/CT Imaging – A Teaching File, Springer 2009 (in press)
Influence of Blood Glucose Levels on Detection of Hepatic Metastases

- 8 patients with 20 liver metastases (10-75 mm)
- Fasting → Glycemia: 92 mg/dl
  - All metastases detectable
  - SUV: 9.4 +/- 5.7
- Glucose infusion IV 4 mg/kg/min → Glycemia: 158 mg/dl
  - 6 metastases not detectable
  - 10 metastases less well seen
  - SUV: 4.3 +/- 8.3
- Conclusion: Fasting and blood glucose levels are required

Grappa F et al. Tumori 1997;83(4): 748-52
FDG PET for Detection of Metastases in Patients with Rising CEA levels and Normal Work-up

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>No patients</th>
<th>Sensitivity</th>
<th>Specificity</th>
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<tr>
<td>Flanagan</td>
<td>1998</td>
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<td>77%</td>
<td>100%</td>
</tr>
<tr>
<td>Valk</td>
<td>1999</td>
<td>32</td>
<td>90%</td>
<td>92%</td>
</tr>
<tr>
<td>Maldonado</td>
<td>2000</td>
<td>72</td>
<td>94%</td>
<td>83%</td>
</tr>
<tr>
<td>Flamen</td>
<td>2001</td>
<td>43</td>
<td>79%</td>
<td>100%</td>
</tr>
</tbody>
</table>

When the conventional work-up is negative (including CT), FDG PET demonstrates tumor in 84% (142/169) of the patients:

Including hepatic metastases

PET allowed surgical resection in 26% of patients

44-year-old man with a history of colon ca with rising CEA levels.
## Clinical Impact of FDG PET in Colorectal Cancer

<table>
<thead>
<tr>
<th>Reference</th>
<th>No patients</th>
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<th>Unsuspected</th>
<th>Clinical Impact</th>
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<td>Beets 94</td>
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<td>40% (14/35)</td>
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<tr>
<td>Schiepers 95</td>
<td>76</td>
<td>95-98%</td>
<td>13% (10/76)</td>
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<tr>
<td>Lai 96</td>
<td>34</td>
<td></td>
<td></td>
<td>32% (11/34)</td>
</tr>
<tr>
<td>Delbeke 97</td>
<td>61</td>
<td>92%</td>
<td>28% (17/61)</td>
<td>28% (17/61)</td>
</tr>
<tr>
<td>Ogunbiyi 97</td>
<td>23</td>
<td></td>
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<td>44% (10/23)</td>
</tr>
<tr>
<td>Valk 99</td>
<td>155</td>
<td></td>
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<td>34% (17/73)</td>
</tr>
<tr>
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<td></td>
<td>15% (9/60)</td>
<td>20% (21/103)</td>
</tr>
<tr>
<td>Imdhal 00</td>
<td>71</td>
<td></td>
<td>21% (16/71)</td>
<td>21% (16/71)</td>
</tr>
<tr>
<td>Staib 00</td>
<td>100</td>
<td>95%</td>
<td></td>
<td>61% (61/100)</td>
</tr>
<tr>
<td>Kalff 00</td>
<td>102</td>
<td></td>
<td></td>
<td>65% (66/102)</td>
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<tr>
<td>Strasberg 01*</td>
<td>43</td>
<td></td>
<td>23% (10/43)</td>
<td>14% (6/43)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>803</strong></td>
<td></td>
<td><strong>25% (108/441)</strong></td>
<td><strong>36% (238/645)</strong></td>
</tr>
</tbody>
</table>
Impact of FDG PET in the Management of Colorectal Hepatic Metastases: Meta-analysis

- Pooled Sensitivity and Specificity of FDG PET and CT from studies in patients evaluated for hepatic resection:
  - Hepatic metastases:
    - Sensitivity: PET 88%  CT 82%
    - Specificity: PET 96%  CT 84%
  - Extrahepatic metastases:
    - Sensitivity: PET 91%  CT 61%
    - Specificity: PET 95%  CT 91%
- Change in management: 31% (range 20-58%)

Clinical Impact of FDG PET in Patients with Colorectal Carcinoma: Survival data

- **Survival at 3 years** of patients with FDG PET: 77% (higher than historical series).
- **Survival at 5 years** of patients with hepatic metastases preoperatively staged with:
  - CIM (19 studies with 6,019): 30%
  - FDG PET (100 patients): 58%

  Contribution: Detection of occult disease and reduction of futile surgeries

Contrast-enhanced CT versus PET/CT

- 76 patients referred for resection of hepatic metastases

Hepatic metastases:
- Sensitivity: 95% (CT) = 91% (PET/CT)
- PET better for hepatic recurrence with specificity of 100% compared to 50% for CT

Local recurrence:
- Sensitivity: 53% (CT) < 93% (PET/CT)

Extrahepatic metastases:
- Sensitivity: 64% (CT) < 89% (PET/CT)

Impact on management for PET/CT: 21% of patients

PET/CT false-negative:
- Lesions < 5 mm
- Chemotherapy during month before PET/CT

PET/ceCT vs PET/non ceCT

54 patients referred for restaging
- PET/non ceCT > ceCT in 50% patients
  - Changed therapy in 5 patients
  - Due to detection of additional lesions
- PET/ceCT > PET/non ceCT in 72% patients
  - Changed therapy in 23 patients
  - Mainly due to correct segmental localization of liver metastases

53 patients referred for nodal staging of rectal cancer
- Accuracy PET/ceCT (79%) > PET/non ceCT (70%) but not statistically significant
- More accurate for pararectal, internal iliac and obturator LN

Tateishi U et al. EJ NMMI 2007:34(10):1627-1634
Measuring Response to Therapy with PET

- Residual tumor at surgical site or post-surgical staging
- Response to radiation therapy
- Response to chemotherapy
  - Early
  - After completion
- Response to neo-adjuvant therapy
- Response to hormonal therapy (Flare phenomenon)
- Response to biological therapy:
  - e.g., response modifiers (IL-2, interferon)
  - e.g., response to monoclonal antibodies
- Response to interventional/regional therapy to the liver
FDG PET for Colorectal Cancer: Hepatic metastases response to chemotherapy

- 20 patients with 27 liver metastases treated with 5FU

Results

- FDG PET baseline:
  - T/L ratio and SUV did not correlate with tumor response (tumor size on CT at 12 weeks)
- FDG PET 4-5 weeks on therapy:
  - Decrease T/L and SUV correlate with tumor response:
    - FDG PET > 15% T/L decrease identified responders with 100% sensitivity, 75% specificity

Conclusions: FDG PET can detect non-responders 4-5 weeks into chemotherapy with 5-FU

Patient with colorectal cancer metastatic to the liver: JTG #02-S012-803

2/8/07
3/16/07 Improvement
6/25/07 Improvement
FDG PET for Colorectal Cancer:
Detection of hepatic metastases after chemotherapy

42 patients evaluated for resection of hepatic metastases
- 29 patients: (69 lesions) no chemotherapy
  - SUV: 6.6 (2.2-13)
  - Hexokinase activity: 23.4 (8.4-40.4)
  - 23% (16/69) lesions not detected
- 13 patients (41 lesions): adjuvant 5FU based chemotherapy within 3 months of resection
  - SUV lower: 4.5 (2.2-8.1)
  - Hexokinase activity lower: 14.4 (3.4-31)
  - 3 patients with lesions at pathology not detected
  - 37% (15/41) lesions not detected

Conclusions: FDG PET should be interpreted in the context of cytotoxic therapy

FDG PET for Colorectal Cancer: Detection of hepatic metastases after neoadjuvant chemotherapy

- 7 patients/65 lesions who underwent hepatic resection after downstaging with 5FU-based chemotherapy

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
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<tbody>
<tr>
<td>CT:</td>
<td>92%</td>
<td>42%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET:</td>
<td>58%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
</tr>
</tbody>
</table>

100% (lesions > 2 cm)
17% (lesions < 2 cm)

Conclusions: FDG PET is suboptimal for detection of hepatic metastases < 2 cm after neoadjuvant chemotherapy

Takahashi S et al. Anticancer Res 2006;26 (6C):4705-4511
19 patients/65 lesions who underwent hepatic resection after downstaging with 5FU/Folfox/Folfiri-based chemotherapy

- Median time end chemo and CT: 3.4 weeks
- Median time end chemo and PET: 5.9 weeks
- Median time end chemo and surgery: 9.9 weeks

Sensitivity lesion-based:
- PET 62%: lesions > 1 cm = 74%, lesions < 1 cm = 18%
- CT 70%

Complete agreement with histology
- PET: 5 patients
- CT: 3 patients

Conclusions: Both PET and CT have suboptimal sensitivity to detect hepatic metastases after neoadjuvant chemotherapy, especially for lesions < 1 cm

FDG PET for Colorectal Cancer: Detection of hepatic metastases after neoadjuvant chemotherapy

FDG PET for Colorectal Cancer: Detection of hepatic metastases after neoadjuvant chemotherapy

- Patients who underwent hepatic resection immediately or after downstaging with 5FU/Folfox/Folfiri-based chemotherapy
  - Group 1 (27 patients): immediate resection
  - Group 2 (48 patients): preop neoadjuvant chemo
  - FDG PET at least 2 weeks after last chemo
- Sensitivity for detection of metastases:
  - FDG PET: Group 1 (93%) > Group 2 (49%)
  - CT: Group 1 (87.5%) > Group 2 (65%)

Conclusions:
- PET and CT have a lower sensitivity for detection of hepatic metastases after neoadjuvant chemotherapy
- CT is slightly more sensitive than FDG PET

### Table 3  FDG-PET and CT—Comparison With Pathological Results

<table>
<thead>
<tr>
<th></th>
<th>Group 1 $n=33$</th>
<th>Group 2 $n=122$</th>
<th>$P$ value</th>
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<td><strong>PET</strong></td>
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<td></td>
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<tr>
<td>TP</td>
<td>29</td>
<td>48</td>
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<tr>
<td>True negative</td>
<td>–</td>
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<tr>
<td>(complete response)</td>
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<td>FP</td>
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</tr>
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<td>FN</td>
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<tr>
<td>Sensitivity</td>
<td>93.3%</td>
<td>49%</td>
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<td>Specificity</td>
<td>–</td>
<td>83.3%</td>
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<tr>
<td><strong>CT</strong></td>
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<td>TP</td>
<td>28</td>
<td>64</td>
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<tr>
<td>True negative</td>
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<td>18</td>
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<td>(complete response)</td>
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<td>Sensitivity</td>
<td>87.5%</td>
<td>65.3%</td>
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<tr>
<td>Specificity</td>
<td>–</td>
<td>75%</td>
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</table>

Group 1, immediate hepatic resection; group 2, hepatic resection following neoadjuvant chemotherapy.
Table 4  Sensitivity of FDG-PET: Correlation With Tumor Size

<table>
<thead>
<tr>
<th>Tumor size</th>
<th>&lt;1 cm</th>
<th>1–3 cm</th>
<th>&gt;3 cm</th>
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<tr>
<td>Group 1 sensitivity</td>
<td>33%</td>
<td>100%</td>
<td>92%</td>
</tr>
<tr>
<td>(total no. of lesions)</td>
<td>(n=3)</td>
<td>(n=15)</td>
<td>(n=13)</td>
</tr>
<tr>
<td>Group 2 sensitivity</td>
<td>17%</td>
<td>78%</td>
<td>100%</td>
</tr>
<tr>
<td>(total no. of lesions)</td>
<td>(n=35)</td>
<td>(n=41)</td>
<td>(n=22)</td>
</tr>
</tbody>
</table>

Group 1, immediate hepatic resection; group 2, hepatic resection following neoadjuvant chemotherapy
FDG PET for Colorectal Cancer: Detection of hepatic metastases after neoadjuvant chemotherapy

- 14 patients/34 lesions with complete metabolic response who had histological examination

- Sensitivity
  - PET lesion-based: 15% (5/34)
  - PET patient-based: 21% (3/14)
  - Complete metabolic and CT response in 7 lesions: 6 still had viable tumor

- Complete agreement with histology
  - PET: 5 patients
  - CT: 3 patients

- Conclusions:
  - PET have suboptimal sensitivity to detect hepatic metastases after neoadjuvant chemotherapy
  - Curative resection should not be deferred based on FDG PET

Figure 1 CT (above) and FDG-PET (below) images of a patient with colorectal hepatic metastases (circled). Before chemotherapy (left), the lesions demonstrated intense FDG uptake before chemotherapy. After chemotherapy (right), one lesion had disappeared on CT (complete RECIST response, top) with the other two also dramatically shrinking in size (partial RECIST response), with all three lesions demonstrating complete resolution of FDG uptake.
Figure 2 Hematoxylin and eosin (H&E)-stained histological section from a hepatic metastasis from colorectal cancer, demonstrating viable tumor present only at the marginal interface (b) between tumor (a) and normal liver parenchyma (c) (original magnification ×4).
FDG PET for Monitoring Regional Therapy to the Liver

- Hepatic metastases:
  - Chemoembolization
  - RFA and cryosurgery
  - $^{90}$Y-microspheres

Monitoring Response to Chemoembolization

FDG PET better than lipiodol retention on CT
Change in FDG uptake correlate with the change in tumor markers

Pre-therapy
Post-therapy

CT
FDG PET
Residual tumor

FDG PET for Monitoring Therapy with $^{90}\text{Y}$-microspheres

FDG PET, CT, MRI and CEA before and 3 months post-therapy with $^{90}\text{Y}$-microspheres*.

- FDG PET was significantly better than CT to assess response
- The change in FDG uptake correlated with the change in CEA levels.
- FDG PET could identify responders vs non-responders.


May 25, 2003

90Y-microspheres

FDG PET for Monitoring Therapy with RFA

38 year-old with colon cancer who underwent RFA of a liver metastasis 4 months earlier.

52-year-old with hepatic metastasis from pancreatic cancer

Immediately after RFA:
Peripheral enhancement

15 months after RFA:
recurrence
PET guided needle placement for subsequent RFA

11 patients with 19 RFA for colorectal metastasis, 2 days post-RFA
Sensitivity for residual/recurrence: PET/CT 65%  CT 45%

Baseline: Hepatic metastasis

2 days post-RFA: Rim on CT in all patients and PET in 4 patients due to tissue regeneration

133 days post-RFA: Recurrence

Conclusions: FDG PET for Colorectal Carcinoma

- **Diagnosis:** Incidental focal uptake in GI tract: ~30-50% are malignant

- **Detection of recurrence:**
  - Presurgical tumor N and M staging
  - Unsuspected metastases: high rate of detection
  - Hepatic metastases: PET > MR > CT > US
  - Extrahepatic metastases: PET > CT
  - Rising CEA levels in the absence of a known source.
  - Equivocal lesions on other imaging modalities, for example:
    - Evaluation of postsurgical sites
    - Indeterminate pulmonary nodules, hepatic lesions lymph nodes
  - Change in management: ~30% of patients
Conclusions: PET/CT for Hepatic Metastases from Colorectal Cancer

- FDG PET/CT for detection of hepatic metastases:
  - Sensitivity (patient): ~ 90% range > MR no Gad > ceCT
  - Sensitivity (lesion): ~ 75% range > MR no Gad > ceCT
    - MR with SPIO: ~90%
  - False -: small size (< 2 cm), mucinous primary, hyperglycemia
  - For recurrence: specificity FDG PET/CT (~90%) >> ceCT (~50%)
  - FDG PET/ceCT > FDG PET/non ceCT for segmental localization

- After chemotherapy:
  - Decrease FDG T/L and SUV can identify responders 4-5 weeks into therapy
  - Sensitivity for detection of residual tumor after chemotherapy:
    - FDG PET: ~ 50%-60%
    - CT: ~60-90%
Thank you!
Sources of False +/- Interpretations

- **F+: Inflammation**
  - Therapy-related
    - Ostomies,
    - Drainage tubes,
    - Stents (percutaneous more common),
    - Radiation therapy
  - Trauma
  - Infection
    - Abscesses,
    - Acute cholecystitis,
    - Acute cholangitis,
    - Acute pancreatitis (chronic pancreatitis but uncommon),
    - Inflammatory bowel disease,
    - Ivermectin
  - Granulomatous disease: TB, fungi

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Sources of False +/- Interpretations

- False negative include:
  - Small lesions (<5-10 mm, i.e. ampullary carcinomas, miliary carcinomatosis)
  - Low cellular density
    - Tumors of the infiltrating type (cholangiocarcinomas)
    - Tumors with large mucinous components
    - Tumor necrosis
    - After chemotherapy
  - Some low-grade tumors: Lymphoma, sarcoma,…
  - Low sensitivity: ~ 50-80%
    - GU: Prostate, Renal cell
    - GYN: Ovarian (mucinous, miliary spread)
    - Hepatocellular
    - Differentiated neuroendocrine
    - Bronchioalveolar
- Hyperglycemia and/or insulin less than 3 H prior to FDG
FDG PET for Colorectal Cancer: Monitoring Therapy

- Locally advanced rectal cancer: Radiation
  - FDG PET can monitor XRT:
    - Sensitivity 84%
    - Specificity 88%
    - More accurate after 6 months*:
      False + due to post-radiation inflammatory changes

### Table 2. The Sensitivity, Specificity, Accuracy, Positive Predictive Value, and Negative Predictive Value of 18-Fluorodeoxyglucose PET in Detecting Pelvic Recurrence in the Previously Irradiated Rectal Cancer Patient

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>SENS (95% CI)</th>
<th>SPEC (95% CI)</th>
<th>ACC (95% CI)</th>
<th>PPV (95% CI)</th>
<th>NPV (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>60</td>
<td>84% (66–97%)</td>
<td>88% (76–96%)</td>
<td>87% (77–95%)</td>
<td>76% (58–92%)</td>
<td>92% (82–99%)</td>
</tr>
<tr>
<td>RT/PET interval (mo)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6–12</td>
<td>20</td>
<td>80% (28–99%)</td>
<td>80% (52–96%)</td>
<td>80% (56–94%)</td>
<td>57% (18–90%)</td>
<td>92% (64–100%)</td>
</tr>
<tr>
<td>&gt;12</td>
<td>40</td>
<td>86% (66–99%)</td>
<td>92% (80–100%)</td>
<td>90% (79–98%)</td>
<td>86% (66–99%)</td>
<td>92% (80–100%)</td>
</tr>
<tr>
<td>p Value</td>
<td>0.76</td>
<td>0.25</td>
<td>0.28</td>
<td>0.15</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

ACC, accuracy; CI, confidence interval; NPV, negative predictive value; PPV, positive predictive value; RT/PET interval, interval between completion of EBRT and performance of 18-fluorodeoxyglucose PET; SENS, sensitivity; SPEC, specificity.
FDG PET for Colorectal Cancer: Monitoring Therapy

**Rectal cancer: Chemoradiation (5FU):**
- 15 patients with pathological response
- The degree of histological response correlated better with PET than CT:
  - Sensitivity PET: 100%
  - Sensitivity CT: 78%

Rectal cancer: Chemoradiation (5FU)

- FDG PET 4-5 weeks after completion of chemoradiation:
- Good prediction of long-term outcome (42 months):
  - Recurrence free: Decrease SUV = mean 69%
  - Recurrence: Decrease SUV = mean 37%

FDG PET for Monitoring Therapy with RFA in the Liver

- **23 patients with colorectal hepatic metastases***
  - FDG PET after 3 weeks: 80% PPV, 100% NPV (recurrence in 4/5 FDG+ but 0/51 FDG-)

- **17 patients with colorectal hepatic metastases**
  - FDG PET performed at 1 week and 1 and 3 months
  - FDG- and CT- in 24/28 metastases (13 patients): no recurrence
  - FDG+ (1 week and 1 months) but CT-: all had recurrence

- **11 patients: FDG-PET detected all recurrences, CT ~ 50%**

- **58 patients with colorectal metastasis post-RFA**: 
  - CT immediately can not predict recurrence: rim of enhancement for months
  - FDG-PET at 3 weeks predicted 5/7 recurrence

FDG PET for Monitoring Therapy with RFA in the Liver

- Study in mini pigs: 19 RFA sessions on non-tumorous liver
  - Comparison CT, MRI and FDG PET/CT immediately after RFA
    - Morphological imaging: rim of enhancement
    - FDG PET: no rim of uptake

46-year-old male s/p low anterior resection for colon cancer 2 weeks earlier.

Diagnosis:
1) Hepatic metastasis
FDG PET and PET-CT: Impact on Management

**Diagnostic Accuracy**
- **FDG PET**: superior diagnostic accuracy than conventional imaging for staging and restaging FDG-avid malignancies
- **PET/CT**: incremental impact on diagnostic accuracy: 40-50% patients
  - Discriminating metastatic from physiologic foci
  - Improving lesions detection on both PET and CT
  - Localizing precisely metastatic foci

**Impact on Management**:
- **FDG PET**: ~30% patients (range 10%-60%)
- **PET/CT**: incremental impact on Patient’s management: 10-20% patients, including
  - Planning radiation therapy
  - Guiding biopsies.
Colorectal cancer: FDG PET versus PET/CT

- 45 patients: retrospective review
- Standard of reference: Interpretation by a panel of experts
- Incremental diagnostic value of PET-CT:
  - Equivocal: decrease by 50%
  - Characterization: increase by 30%
  - Definite localization: increase by 25%
  - No significant change in sensitivity and specificity
  - Correct staging increased from 78% to 89%