# PET/CT in Gynaecological Cancers

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# Outline of this talk

- Cervix cancer
  - Initial staging
  - Treatment monitoring/guidance (RTP)
  - Early detection of recurrence
- Ovarian cancer
  - DD adnexal mass
  - Initial staging
  - Detection of recurrence

# Cervix Cancer

- Incidence EU 13/100.000 per year
  - Related to HPV infection
  - Decrease expected in future due to vaccination programs

- Important decrease in mortality rates due to screening programs (PAP smear): detection of early stage disease <-> situation in RSA

# Cervical Cancer T-stage

- Based on FIGO classification
  - Stage I limited to cervix
  - Stage II extends beyond the cervix
  - Stage III extends to pelvic wall
  - Stage IV extends into adjacent organs

  ➡ MR = technique of choice

- No additional value for PET due to low anatomical resolution
- FDG uptake correlates with aggressiveness

# Cervical Cancer T-stage

## Baseline FDG uptake as a prognostic factor

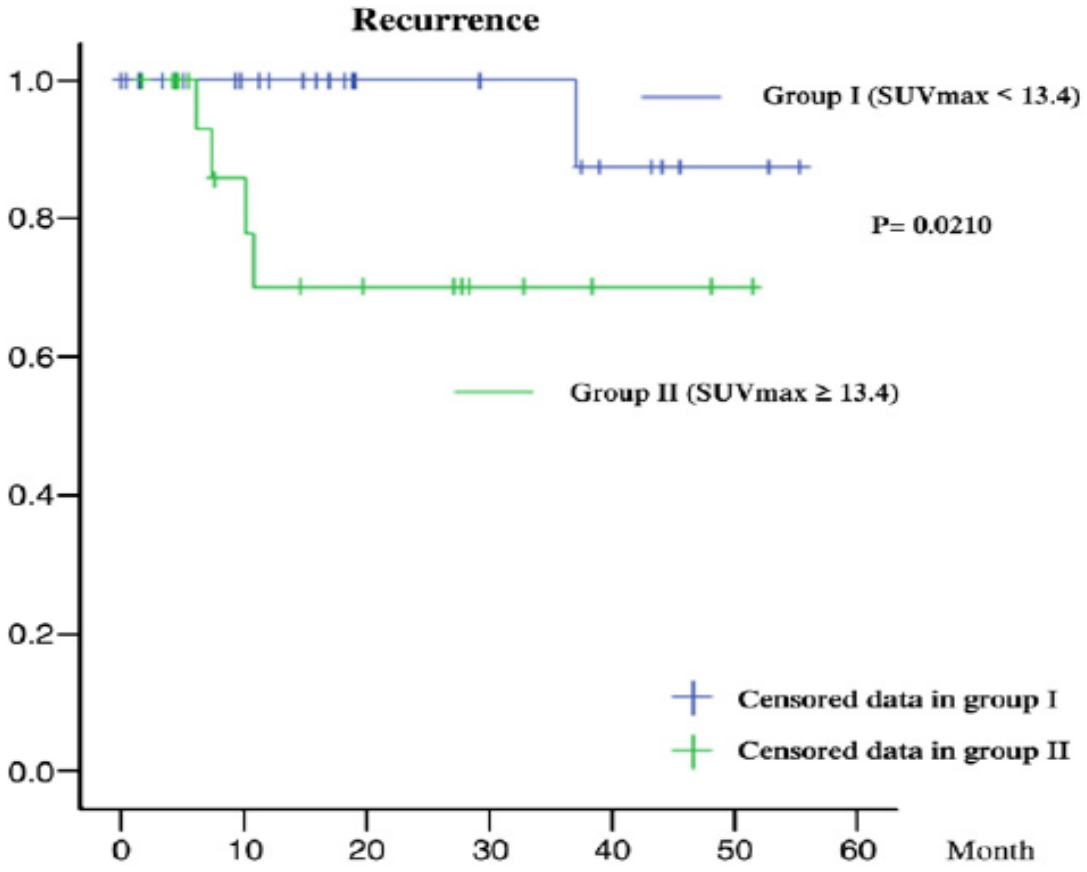



**Fig. 1.** Recurrence rate according to SUVmax of more than 13.4.

Lee et al, Gynecologic Oncology 2009

# Cervical Cancer – N-stage

- Important prognostic factor for outcome (5y survival)
  - No LN ~ 90-95%
  - Pelvic Nodes + ~ 50%
  - Para-aortic LN ~ 30%
- Predictable pattern
  - Parametrial invasion -> pelvic LN -> PALN
  - Skip LN metastasis very rare (1%), microM+ are frequent
- Historically: surgical staging
- Imaging

# PET and PET/CT for Nodal staging

Kitajima et al, Eur Radiol. 2009

- Prospective study in 45 patients with endometrial or cervical cancer with PET/CT prior to lymphadenectomy

- PET/CT on Biograph 16 with optimized protocol
  - Low dose CTAC→PET → diagnostic CT abdomen (IV contrast, 230 mAs, 140 kVp, 2 mm slice thickness)

- Analysis: any uptake > BG projecting in a LN = positive

  LN > 1 cm but PET neg is regarded benign

# PET and PET/CT for Nodal staging

## Kitajima et al, Eur Radiol. 2009

**Table 2** Overall patient- and node-based diagnostic accuracy of PET/CT

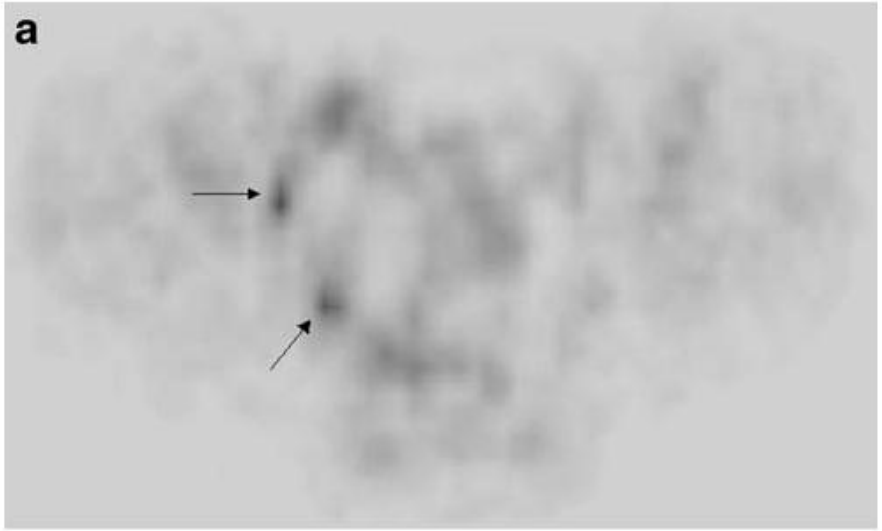
| | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|
| All patients | 50.0% | 90.9% | 66.7% | 83.3% | 80.0% |
| (*n*=45) | 6/12 | 30/33 | 6/9 | 30/36 | 36/45 |
| All lymph nodes | 51.1% | 99.8% | 85.2% | 98.9% | 98.7% |
| (*n*=1,976) | 23/45 | 1,927/1,931 | 23/27 | 1,927/1,949 | 1,950/1,976 |
| Pelvic lymph nodes | 52.2% | 99.8% | 85.7% | 99.1% | 98.9% |
| (*n*=1,223) | 12/23 | 1,198/1,200 | 12/14 | 1,198/1,209 | 1,210/1,223 |
| Paraaortic lymph nodes | 50.0% | 99.7% | 84.6% | 98.5% | 98.3% |
| (*n*=753) | 11/22 | 729/731 | 11/13 | 729/740 | 740/753 |

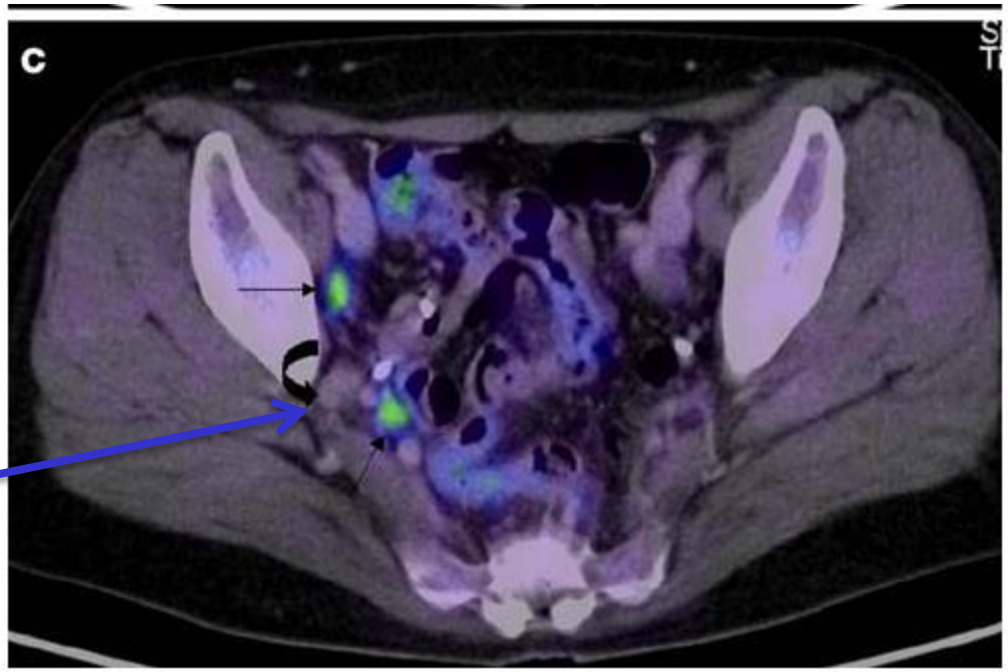
**Table 3** Node-based sensitivity of PET/CT according to the node size

| Node size (mm) | Sensitivity (%) |
|---|---|
| 2–4 | 12.5 (2/16) |
| 5–9 | 66.7 (16/24) |
| 10–12 | 100 (5/5) |
| Total | 51.1 (23/45) |

# PET and PET/CT for Nodal staging

Kitajima et al, Eur Radiol. 2009




**False negative lymph node of 9 mm**

# Cervical Cancer – Nodal Staging

Meta-analysis Choi et al. Cancer Science, June 2010

**Table 4. Summary sensitivity and specificity of CT, MRI, and PET or PET/CT**

| Category | No. of studies | Summary sensitivity, % (95% CI) | Summary specificity, % (95% CI) |
|---|---|---|---|
| Patient-based comparison | | | |
| CT | 16 | 50 (43–57) | 92 (90–94) |
| MRI | 21 | 56 (51–62) | 91 (90–93) |
| PET or PET/CT | 12 | 82 (75–87) | 95 (93–97) |
| Region/node-based comparison | | | |
| CT | 4 | 52 (42–62) | 92 (90–94) |
| MRI | 9 | 38 (32–43) | 97 (97–98) |
| PET or PET/CT | 8 | 54 (46–61) | 97 (96–98) |

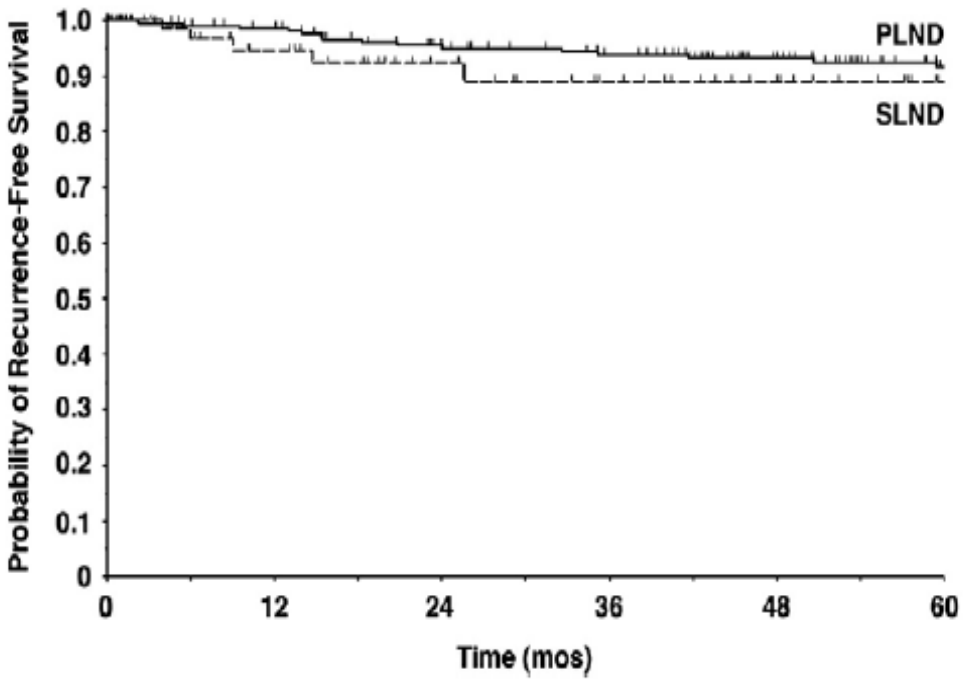
**Table 5. Pair-wise comparisons between modalities for sensitivity, specificity, AU**

| Category | Sensitivity | Specificity |
|---|---|---|
| Patient-based comparison | | |
| CT *vs* MRI | 50% *vs* 56% (0.19) | 92% *vs* 91% (0.43) |
| CT *vs* PET or PET/CT | 50% *vs* 82% (<0.001†) | 92% *vs* 95% (0.04†) |
| MRI *vs* PET or PET/CT | 56% *vs* 82% (<0.001†) | 91% *vs* 95% (<0.001†) |
| Region/node-based comparison | | |
| CT *vs* MRI | 52% *vs* 38% (0.02†) | 92% *vs* 97% (<0.001†) |
| CT *vs* PET or PET/CT | 52% *vs* 54% (0.75) | 92% *vs* 97% (<0.001†) |
| MRI *vs* PET or PET/CT | 38% *vs* 54% (<0.001†) | 97% *vs* 97% (1.00) |

# Sentinel Node Imaging in Cervical Cancer

L. Gortzak-Uzan et al. Gynecologic Oncology 116 (2010) 28–32
Prospective study 3:1 randomisation of SLND vs Pelvic lymphadectomy

| | SLN ($n=81$) | Control |
|---|---|---|
| Mean age (years) | 38.2 | 41.4 |
| Mean tumour size (mm) | 6.6 | 4.7 |
| Histology (%) | | |
| Squamous cell carcinoma | 42 | 47 |
| Adenocarcinoma | 42 | 42 |
| AdenoSquamous carcinoma | 16 | 11 |
| Mean depth of invasion (mm) | 6.8 | 6.4 |
| Positive CLS (%) | 43.2 | 41.7 |
| Stage (%) | | |
| IA | 39 | 9 |
| IB | 61 | 91 |
| LN+ | 14 (17%) | 15 (7% |



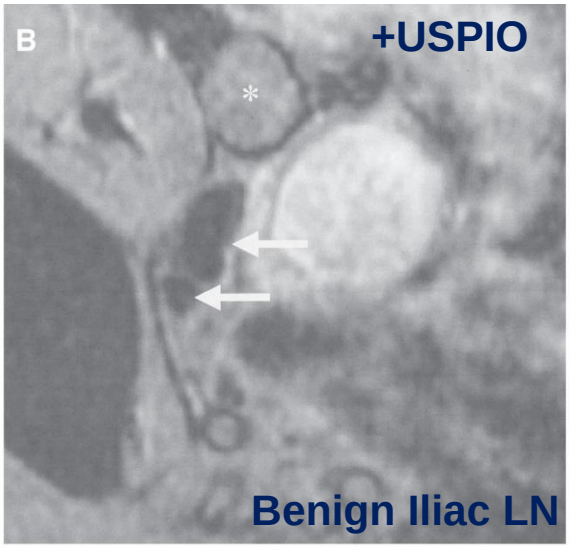

| Site | Number of hemipelvises identified 162 |
|---|---|
| Obturator | 127 (78%) |
| External iliac | 36 (22%) |
| Common iliac | 18 (11%) |
| Internal iliac | 7 (4%) |
| Paraaortic | 1 (1%) |

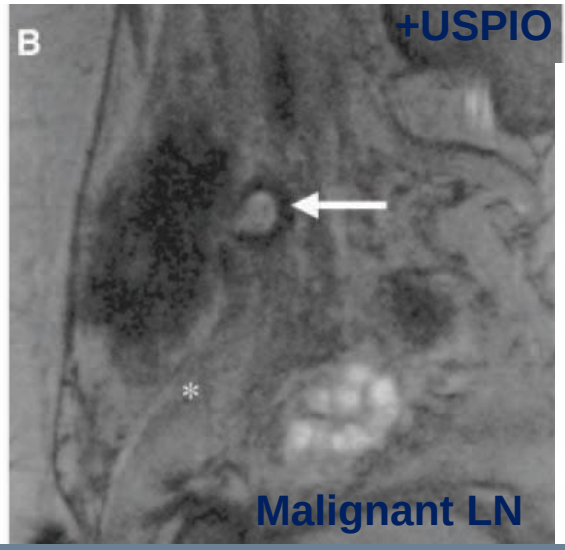
# USPIO-MR for Nodal staging

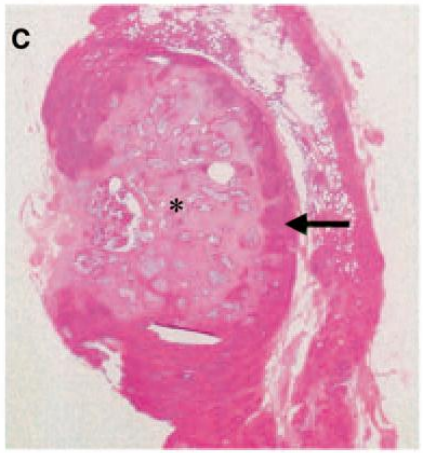
## Rockall et al, JCO 2005

**Table 3.** Diagnostic Performance of Size Criteria* and USPIO Criteria,† Pelvic Side Wall and Para-Aort

| Criteria | No. of Nodes | Histology Negative | | Histology Positive | | Sensitivity | | Specificity | |
|---|---|---|---|---|---|---|---|---|---|
| | | TN | FP | TP | FN | Mean | 95% CI | Mean | 95% CI |
| Size, mm | | | | | | | | | |
| > 5 | 335 | 252 | 66 | 10 | 7 | 0.59 | 0.33 to 0.82 | 0.79 | 0.72 to 0.86‡§ |
| > 8 | 335 | 311 | 7 | 6 | 11 | 0.35 | 0.14 to 0.62‡ | 0.98 | 0.95 to 1.00 |
| > 9 | 335 | 316 | 2 | 5 | 12 | 0.29 | 0.10 to 0.56‡§ | 0.99 | 0.98 to 1.00 |
| > 10 | 335 | 316 | 2 | 4 | 13 | 0.24 | 0.07 to 0.50‡§ | 0.99 | 0.98 to 1.00 |
| Size ratio | 335 | 314 | 4 | 5 | 12 | 0.29 | 0.10 to 0.56‡§ | 0.99 | 0.97 to 1.00 |
| USPIO | | | | | | | | | |
| Reader 1 | 317 | 294 | 9 | 13 | 1 | 0.93 | 0.66 to 1.00‡ | 0.97 | 0.92 to 1.00‡ |
| Reader 2 | 316 | 293 | 9 | 14 | 3 | 0.82 | 0.57 to 0.96§ | 0.97 | 0.94 to 0.98§ |



# Nodal PET stage = Important Prognostic factor

Kidd, .. And Grigsby, J Clin Oncology 2010

Evaluation of the prognostic effect of nodal stage on PET in a prospective cohort of 560 patients with newly diagnosed cervix cancer

**Table 2.** Comparison of Pelvic and Para-Aortic Lymph Node Metastasis by Stage From Combined Historical Data[3,16-19] and Data From This Study With FDG-PET Lymph Node Staging

| | Pelvic Nodal Metastasis (%) | | Para-Aortic Metastasis (%) | |
|---|---|---|---|---|
| FIGO Stage | Historical Data | Current Study | Historical Data | Current Study |
| I | 12-38 | 9-51 | 0-5 | 0-9 |
| IIA | 10-45 | 50 | 0-12 | 21 |
| IIB | 26-62 | 54 | 10-21 | 17 |
| IIIA | 39-59 | 50 | 21-33 | 25 |
| IIIB/IV | 39-88 | 55-85 | 13-38 | 27-60 |

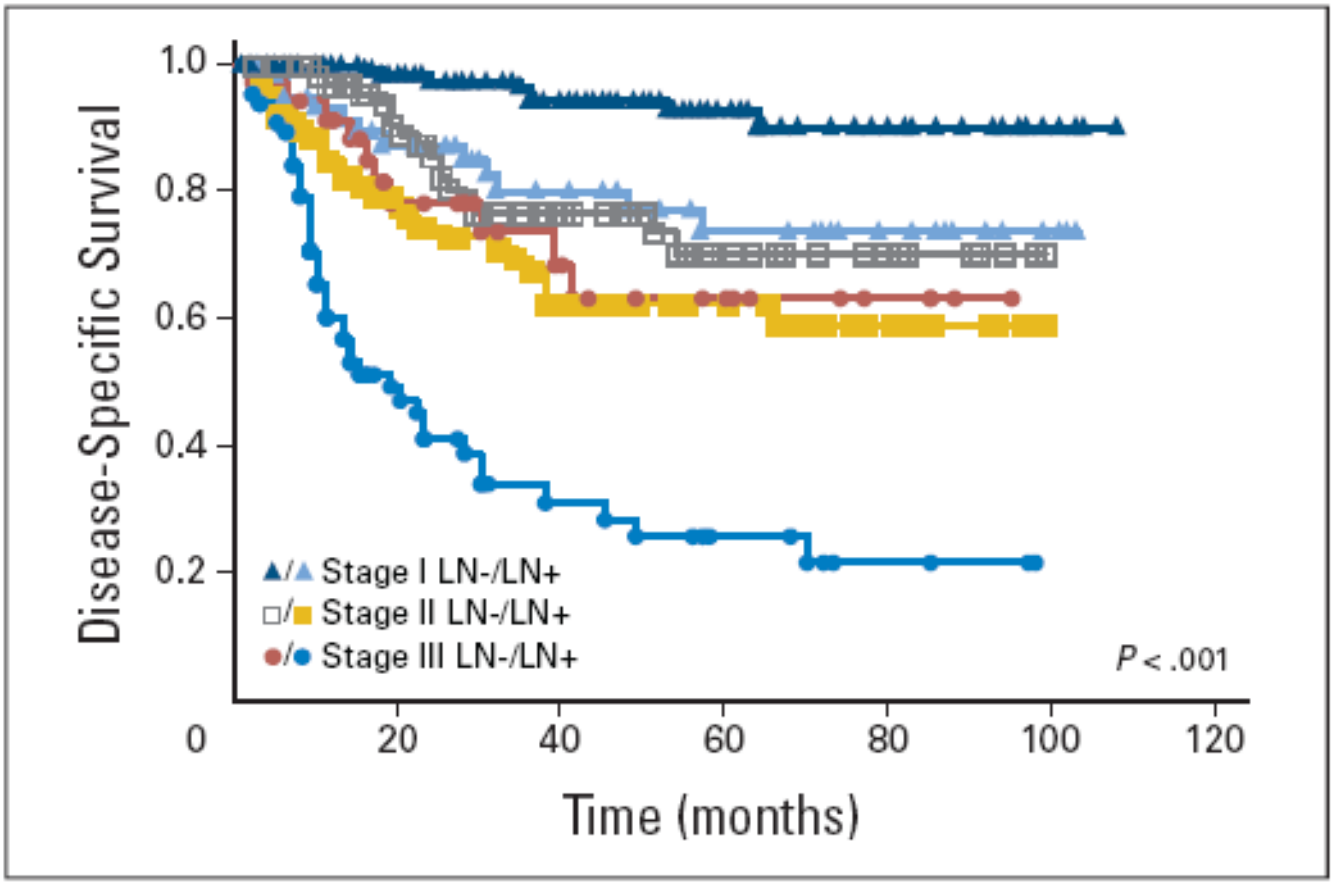
Abbreviations: FDG-PET, positron emission tomography with [$^{18}$F]fluorodeoxyglucose; FIGO, International Federation of Gynecology and Obstetrics.

Incidence of PET+ LN is comparable with historical data after surgical staging

# Lymph Node Staging by Positron Emission Tomography in Cervical Cancer: Relationship to Prognosis

*Elizabeth A. Kidd, Barry A. Siegel, Farrokh Dehdashti, Janet S. Rader, David G. Mutch, Matthew A. Powell, and Perry W. Grigsby*






Prognostic effect in every FIGO stage

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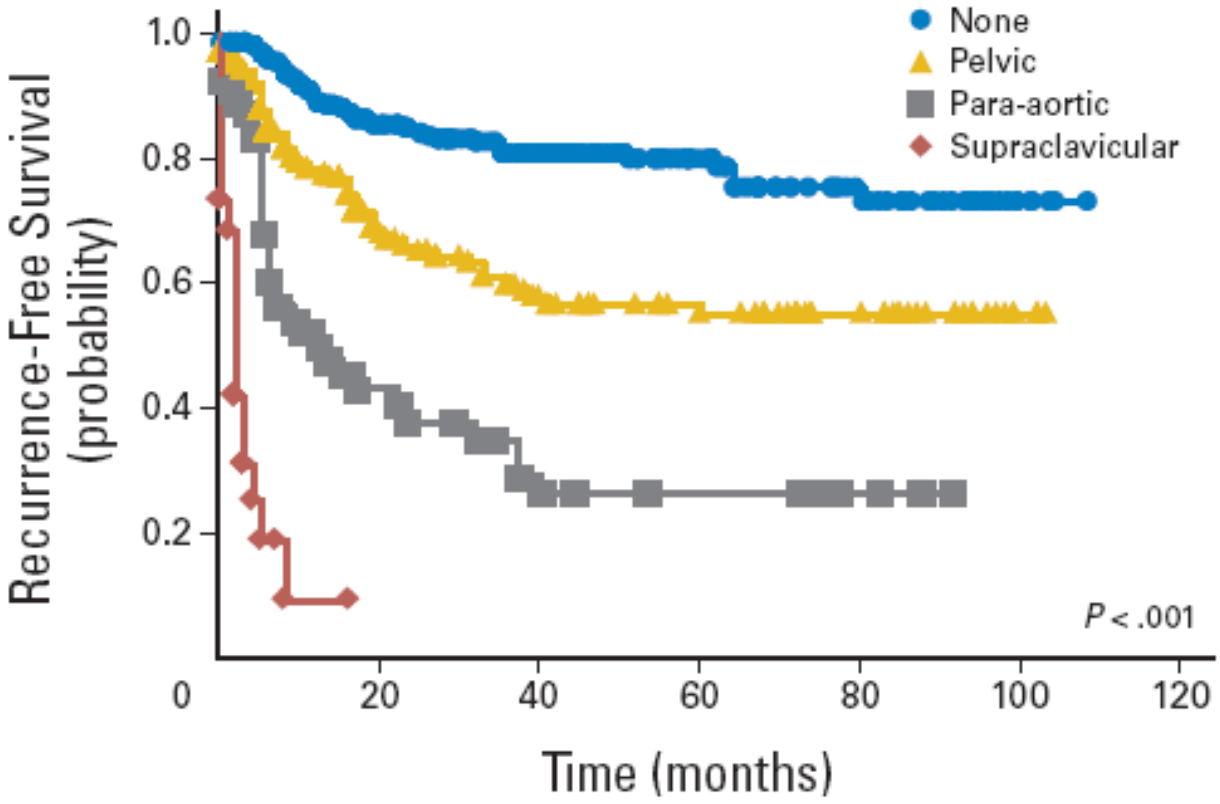
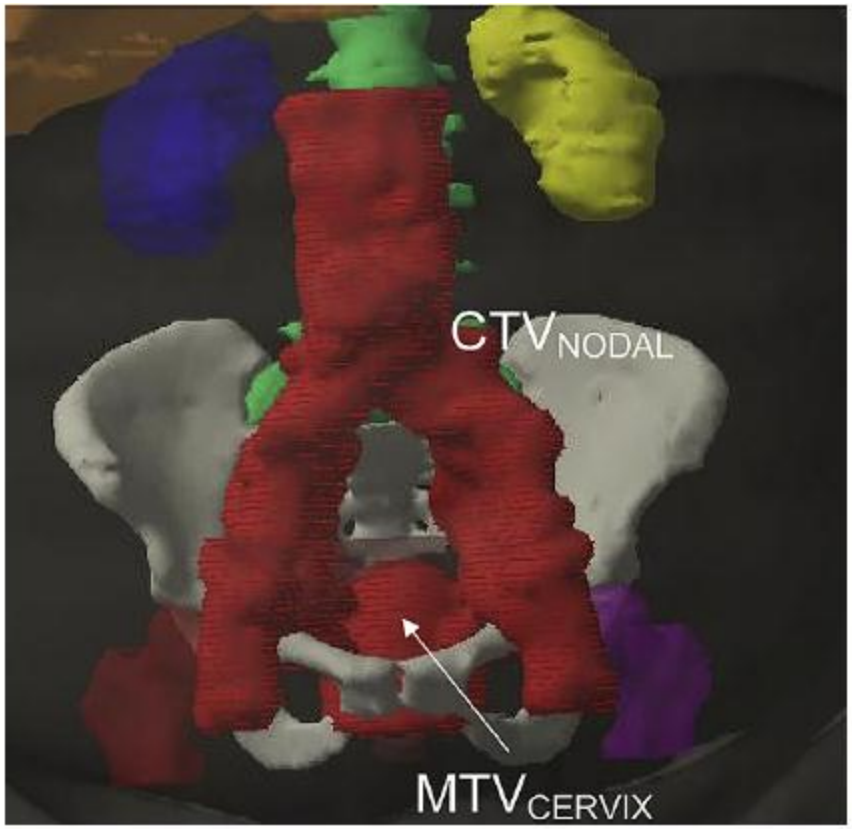



Prognostic effect of highest level of LN involvement independent from FIGO stage

# PET/CT guided IMRT for advanced CC

Kidd, …Grigsby. Int. J. Radiation Oncology Biol. Phys,1085–1091, 2010

- Clinical outcome of PET/CT based IMRT compared to standard RT in a prospective cohort of 452 patients




Before 2005 (n=317)
Whole pelvis and split-field RT (step-wedge technique) + brachytherapy + Cisplatin (83% of patients)

After march 2005
IMRT + brachy + Cisplatin (89%)
Tumor delineation
Primary T : isocontour 40% SUVmax
LN vessel contouring until highest positive LN level + 7mm margin for CTV LN + 7 mm margin PTV nodal

Table 1. Patient and tumor characteristics for the IMRT, non-IMRT, and total groups

| Characteristic | IMRT | Non-IMRT | Total | *p* Value |
|---|---|---|---|---|
| Mean age at diagnosis (y) | 52 | 52 | 52 | |
| Chemotherapy | 120 (89%) | 262 (83%) | 449 | 0.2238 |
| Stage | | | | 0.7003 |
| Ia2 | 0 (0%) | 2 (0.7%) | 2 | |
| Ib1 | 20 (14.8%) | 33 (10.4%) | 53 | |
| Ib2 | 21 (15.6%) | 56 (17.7%) | 77 | |
| IIa | 3 (2.2%) | 7 (2.2%) | 10 | |
| IIb | 58 (43.0%) | 126 (39.7%) | 184 | |
| IIIa | 2 (1.5%) | 2 (0.6%) | 4 | |
| IIIb | 29 (21.5%) | 82 (25.9%) | 111 | |
| IVa | 2 (1.5%) | 7 (2.2%) | 9 | |
| IVb | 0 (0%) | 2 (0.6%) | 2 | |
| Histology | | | | 0.3710 |
| Adenocarcinoma | 13 (9.6%) | 17 (5.4%) | 30 | |
| Adenosquamous | 2 (1.5%) | 9 (2.8%) | 11 | |
| Squamous | 117 (86.7%) | 286 (90.2%) | 403 | |
| Other | 3 (2.2%) | 5 (1.6%) | 8 | |
| Lymph nodes | | | | 0.0309 |
| None | 68 (50.4%) | 131 (41.3%) | 199 | |
| Pelvic only | 41 (30.4%) | 140 (44.2%) | 181 | |
| Para-aortic | 23 (17.0%) | 36 (11.4%) | 59 | |
| Supraclavicular | 3 (2.2%) | 10 (3.2%) | 13 | |

Kidd, …Grigsby. Int. J. Radiation Oncology Biol. Phys,1085–1091, 2010

# PET/CT guided IMRT for advanced CC

Kidd, …Grigsby. Int. J. Radiation Oncology Biol. Phys,1085–1091, 2010

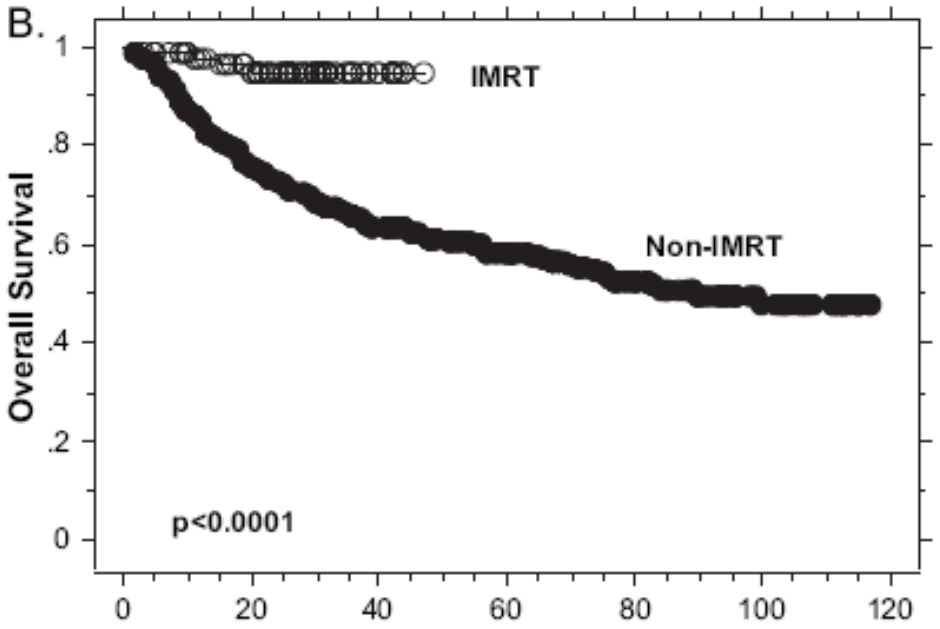



Table 4. Grade 3 or greater gastrointestinal and genitourinary complications in study group

| Complication | IMRT group | Non-IMRT group | Total |
|---|---|---|---|
| Rectovaginal fistula | 2 | 12 | 14 |
| Vesicovaginal fistula | 0 | 11 | 11 |
| Small bowel obstruction | 2 | 7 | 9 |
| Large bowel obstruction | 2 | 5 | 7 |
| Cystitis, Grade 4 | 1 | 5 | 6 |
| Rectal ulcer | 1 | 5 | 6 |
| Ureteral stricture | 0 | 4 | 4 |
| Rectal stricture | 0 | 2 | 2 |
| Proctitis, Grade 4 | 0 | 2 | 2 |
| Ischemic colitis | 0 | 1 | 1 |

Table 2. Distribution of recurrences for the IMRT, non-IMRT, and total groups

| Recurrence | IMRT | Non-IMRT | Total | *p* Value |
|---|---|---|---|---|
| Overall | 39 (28.9%) | 139 (43.8%) | 178 | 0.036 |
| Pelvic | 11 (8.1%) | 33 (10.4%) | 44 | |
| Distant | 21 (15.6%) | 78 (24.6%) | 99 | |
| Both | 7 (5.2%) | 28 (8.8%) | 35 | |

# Detection of recurrence

- Most patients relapse within first 2 year
- Early detection essential for salvage therapy
- How?
  - No reliable tumor marker
  - PAP smear can be FP after RT
  - CT/MR difficult post RT/surgery

- Indication for PET/CT?

# Detection of recurrence

**Table 3** FDG–PET for posttherapy surveillance and recurrence

| | *n* | Study | Imaging modality | Symptom? | Site of relapse | Se | Sp | Recurrence confirmation |
|---|---|---|---|---|---|---|---|---|
| Lai et al.[48] | 45 | P | PET *vs* MRI | Yes | Overall | 0.91 | 0.98 | Histo/follow-up |
| | | | | | | 0.67 | 0.98 | |
| Yen et al.[101] | 55 | R | PET *vs* CT/MRI | Yes | Overall | 0.89 | 0.98 | Histo/follow-up |
| | | | | | | 0.48 | 0.98 | |
| Chang et al.[95] | 27 | P | PET *vs* CT | Yes | Overall | 0.94 | 0.78 | Histo/follow-up |
| | | | | | | 0.50 | 0/2 | |
| Havrilesky et al.[92] | 50 | R | PET | Yes | Overall | 0.86 | 0.87 | Histo/follow-up |
| Unger et al.[71] | 47 | R | PET | No ($n = 21$) | Overall | 0.8 | 1.00 | Histo/follow-up |
| | | | PET | Yes ($l = 26$) | Overall | 1.00 | 0.86 | |
| Sun et al.[90] | 20 | R | PET | Yes | CPR | 0.86 | 0.92 | LND/follow-up |
| | | | | | PELN | 1.0 | 0.94 | |
| | | | | | PALN | 1.0 | 1.0 | |
| Park et al.[17] | 36 | R | PET | No | CPR | 1.00 | 0.94 | Histo/follow-up |
| Husain et al.[97] | 20 | P | PET | Yes | Extra-pelvic | 1.00 | 0.73 | Histo/follow-up |
| Wong et al.[15] | 41 | R | PET | Yes | CPR | 0.82 | 0.97 | Histo/follow-up |
| | | | | | Distant | 1.00 | 0.90 | |
| Chung et al.[95] | 121 | R | PET | Yes | Overall | 0.96 | 0.84 | Histo/follow-up |
| Chung et al.[94] | 52 | R | PET–CT | Yes | Overall | 0.90 | 0.81 | Histo/follow-up |
| Chang et al.[96] | 20 | P | PET | Serum SCC elevation | Overall | 0.97 | – | Histo/follow-up |
| Sakurai et al.[82] | 25 | R | PET | Yes | Overall | 0.91 | 0.57 | Histo/follow-up |
| Ryu et al.[99] | 249 | R | PET | No | Overall | 0.90 | 0.73 | Histo/follow-up |

Se: sensitivity, Sp: specificity, R: retrospective, P: prospective, SLN: sentinel lymph node, CPR: centropelvic relapse, PELN: pelvic lymph node, PALN: para-aortic lymph node, histo: histological examination.

# Can PET with diagnostic CT do beter?

## Kitajima, EJNMM 2009

**Table 1** Patient and tumour characteristics

| Characteristic | Uterine cervical cancer | Endometrial cancer | Total |
|---|---|---|---|
| Number | 50 | 40 | 90 |
| Age (years) | | | |
| Median | 58 | 60 | 59 |
| Range | 37–82 | 38–78 | 37–82 |
| Stage[a] | | | |
| I | 14 | 8 | 22 |
| II | 13 | 12 | 25 |
| III | 19 | 16 | 35 |
| IV | 4 | 4 | 8 |
| Original histology | | | |
| Squamous cell carcinoma | 43 | – | 43 |
| Adenocarcinoma | 5 | – | 5 |
| Adenosquamous cell carcinoma | 2 | 4 | 6 |
| Endometrioid adenocarcinoma | – | 33 | 33 |
| Clear-cell carcinoma | – | 2 | 2 |
| Serous papillary adenocarcinoma | – | 1 | 1 |
| Primary treatment | | | |
| Surgery | 10 | 12 | 22 |
| Surgery + chemotherapy | 10 | 17 | 27 |
| Surgery + chemoradiotherapy | 20 | 9 | 29 |
| Chemoradiotherapy | 10 | 2 | 12 |
| Time from last treatment to PET/CT study (months) | | | |
| Median | 19 | 18 | 17 |
| Range | 6–70 | 6–61 | 6–70 |

[a] International Federation of Gynecology and Obstetrics (FIGO) stage.

# Detection of recurrence

## Kitajima, EJNMM 2009

### A. Patient – based Analysis (N=90)

**Table 2** Patient-based diagnostic results of PET alone, CT alone, and PET/CT

| Modality | True-positive | False-negative | True-negative | False-positive | Sensitivity (95% CI) | Specificity (95% CI) | Accuracy (95% CI) |
|---|---|---|---|---|---|---|---|
| PET | 35 | 9 | 34 | 12 | 79.5 (67.6–91.4) | 73.9 (61.2–86.6) | 76.7 (68.0–85.4) |
| CT | 30 | 14 | 40 | 6 | 68.2 (54.4–81.9) | 87.0 (77.2–96.7) | 77.8 (69.2–86.4) |
| PET/CT | 40 | 4 | 43 | 3 | 90.9 (82.4–99.4) | 93.5 (86.4–100) | 92.2 (86.7–97.8) |

### B. Region based Analysis (N=900)

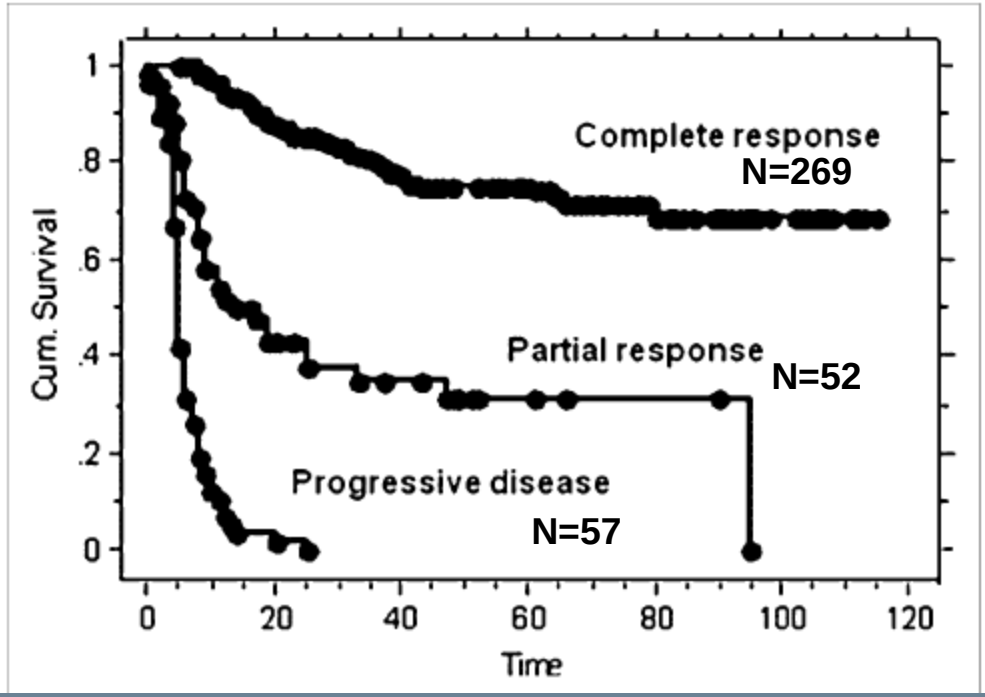
| | Sens (%) | # FN | Spec (%) | # FP | Acc (%) |
|---|---|---|---|---|---|
| PET | 71,4 | 18 | 97,7 | 19 | 95,9 |
| CT | 60,3 | 25 | 99 | 8 | 96,3 |
| PET/CT | 90,5 | 6 | 99,5 | 4 | 98,9 |

PET/CT FN = submm lesions; FP = bowel uptake, sarcoidosis, degenerative bone disease
PETonly FP mostly due to bowel and ureter uptake mimicking disease

Change in patient management in 38/90 patients (42%)

# PET for Response evaluation

- Identify patients with residual disease early to allow salvage surgery
- Schwarz et al. JAMA 2007
  - Retrospective analysis in 378 patients, PET before and 3 m after CRT




Pilot Study in 36 pts of PET during therapy

After 4 weeks,: 4,SD, 26 PR and 6 CR

3m post CRT : 3 PD, 1 PR and 29 CR

Optimal Timing and threshold?
If confirmed adapt therapy early
- boost
- other chemo

# Use of PET/CT in Uterine Cervical Cancer Conclusions

## Early stage Cervical Cancer

- no indication for PET/CT
- Sentinel Node biopsy?

## Locally advanced cervical cancer

- recommended PET/CT for staging (N+/M+)
  → include all PET+ LN in PTV
- Early response assessment (3 m post R/) to guide additional therapy
- Investigational: PET during therapy

## Detection of recurrence

- PET/CT is technique of choice

# PET-CT in Ovarian Cancer

- Characterization of ovarian lesions
- Initial Staging
- Recurrence

# Asymptomatic Adnexal Masses: Correlation of FDG PET and Histology

Fenchel et al Radiology, 2002

- 99 pts asymptomatic mass on abdominal US underwent PET, MR and transvaginal US

**TABLE 4**
**Statistical Results**

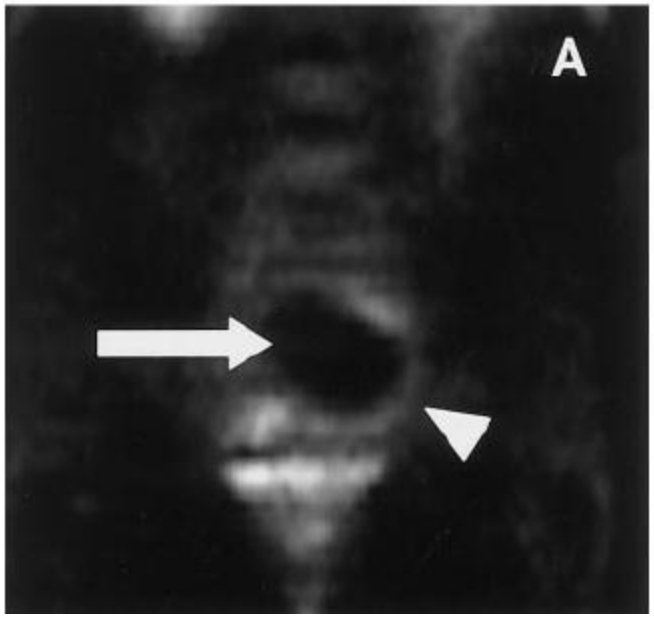
| Modality | Sensitivity | Specificity | Positive Predictive Value | Negative Predictive Value | Accuracy |
|---|---|---|---|---|---|
| FDG PET | 58 (27.7, 84.8) | 76 (65.5, 84.4) | 25 (10.7, 44.9) | 93 (84.3, 97.9) | 74 (63.9, 82.1) |
| Transvaginal US | 92 (61.5, 99.8) | 60 (48.7, 70.1) | 24 (12.6, 38.8) | 98 (89.9, 100) | 64 (53.4, 73.1) |
| MR imaging | 83 (51.6, 97.9) | 84 (74.5, 90.9) | 42 (24.4, 65.1) | 97 (90.7, 99.7) | 84 (75.1, 90.5) |
| Combination of FDG PET, US, and MR imaging | 92 (61.5, 99.8) | 85 (75.8, 91.8) | 46 (25.5, 67.2) | 99 (92.8, 100) | 86 (77.4, 92.0) |

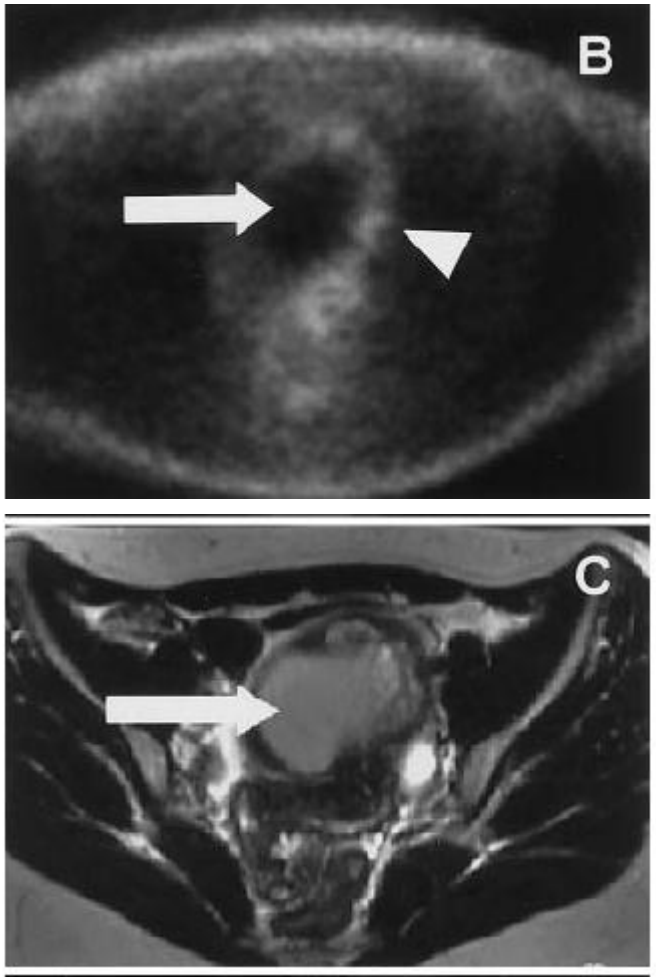
Note.—Data are expressed as percentages. Data in parentheses are 95% CIs.

- 7/12 cancers were detected. FN in 5 pT1a cystadenocarcinomas
- 66/87 benign masses were TN. FP uptake in inflammation, schwannoma, corpus luteum cysts)

# Asymptomatic Adnexal Masses

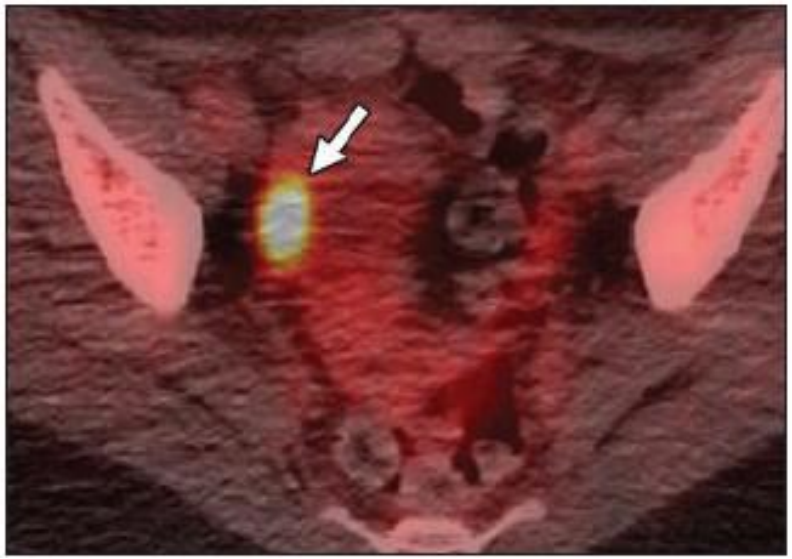
Fenchel et al Radiology, 2002

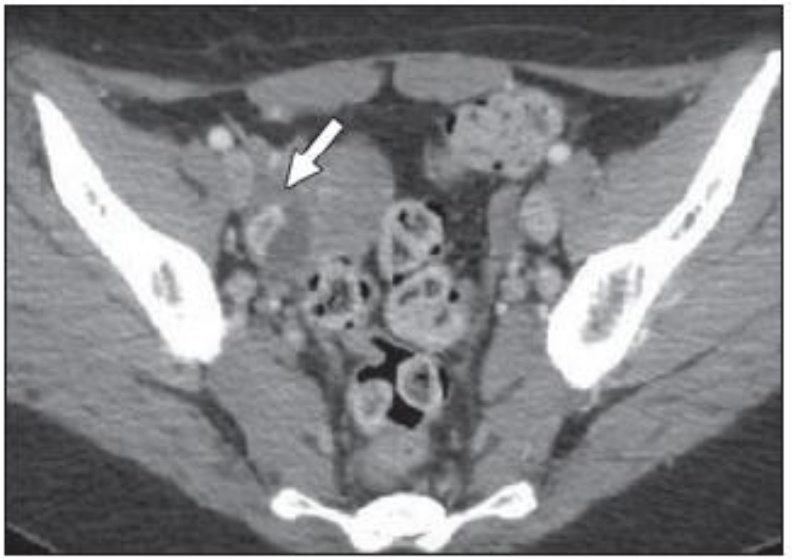



Cystic endometrioma presents as a photopenic defect without elevated FDG uptake. The tumor is surrounded by gastrointestinal activity

# Luteal cyste





# PET for initial Staging of Ovarian Cancer

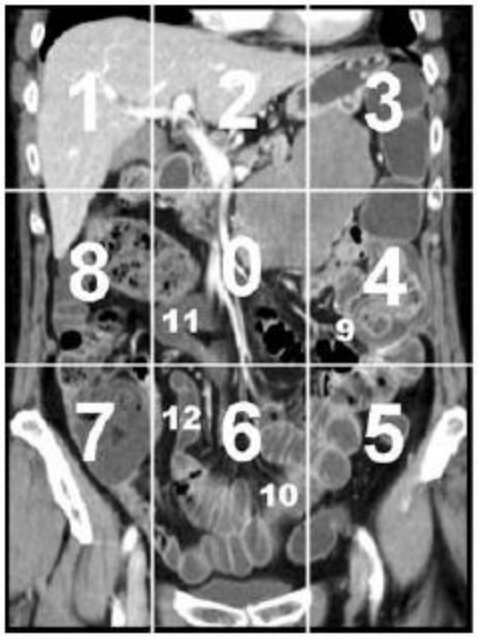
- Patients often present with already advanced stage disease at diagnosis due to lack of specific symptoms.
  - ➢ linked to a poor prognosis (5y survival )

    20–40% for stage III

    10% for stage IV
- Accurate staging important to define optimal treatment strategy (debulking)
  - Presence and location of peritoneal spread
  - Nodal involvement
  - Extra-abdominal or liverinvolvement

# PET for detection of Peritoneal Carcinomatosis

Pfannenberg et al, Annals of Surg Oncol 2009

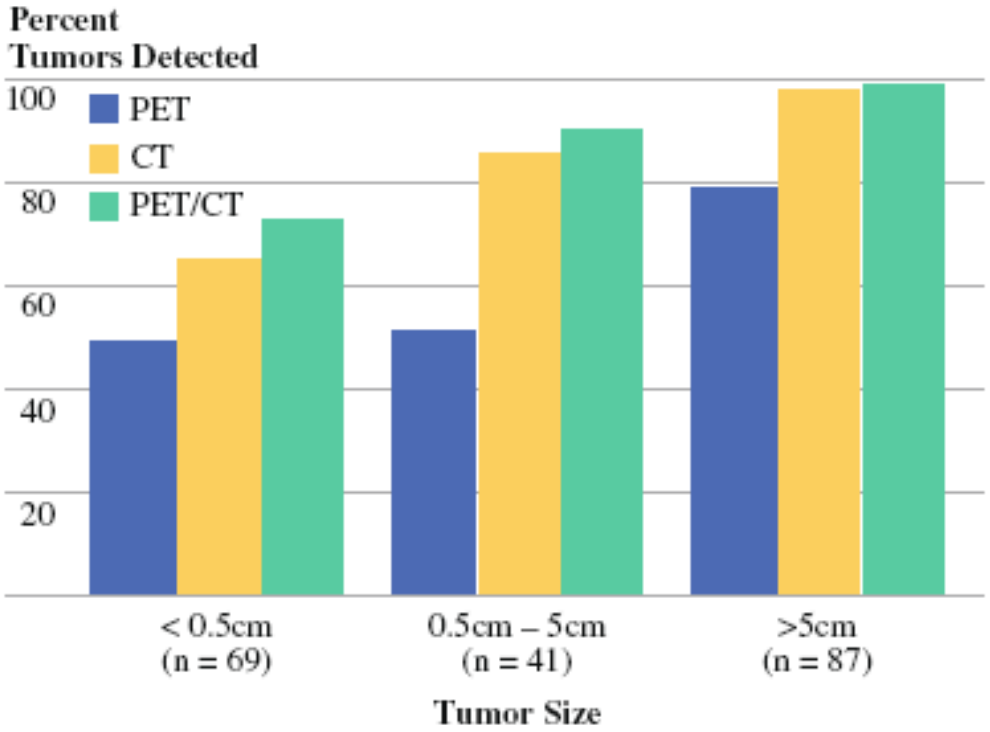



REGIONS

0 = Central
1 = Right upper
2 = Epigastrium
3 = Left upper
4 = Left flank
5 = Left lower
6 = Pelvis
7 = Right lower
8 = Right flank

9 = Upper jejunum
10 = Lower jejunum
11 = Upper ileum
12 = Lower ileum

**FIG. 1** Abdominopelvic regions 0–12 according to the Peritoneal Cancer Index (PCI)

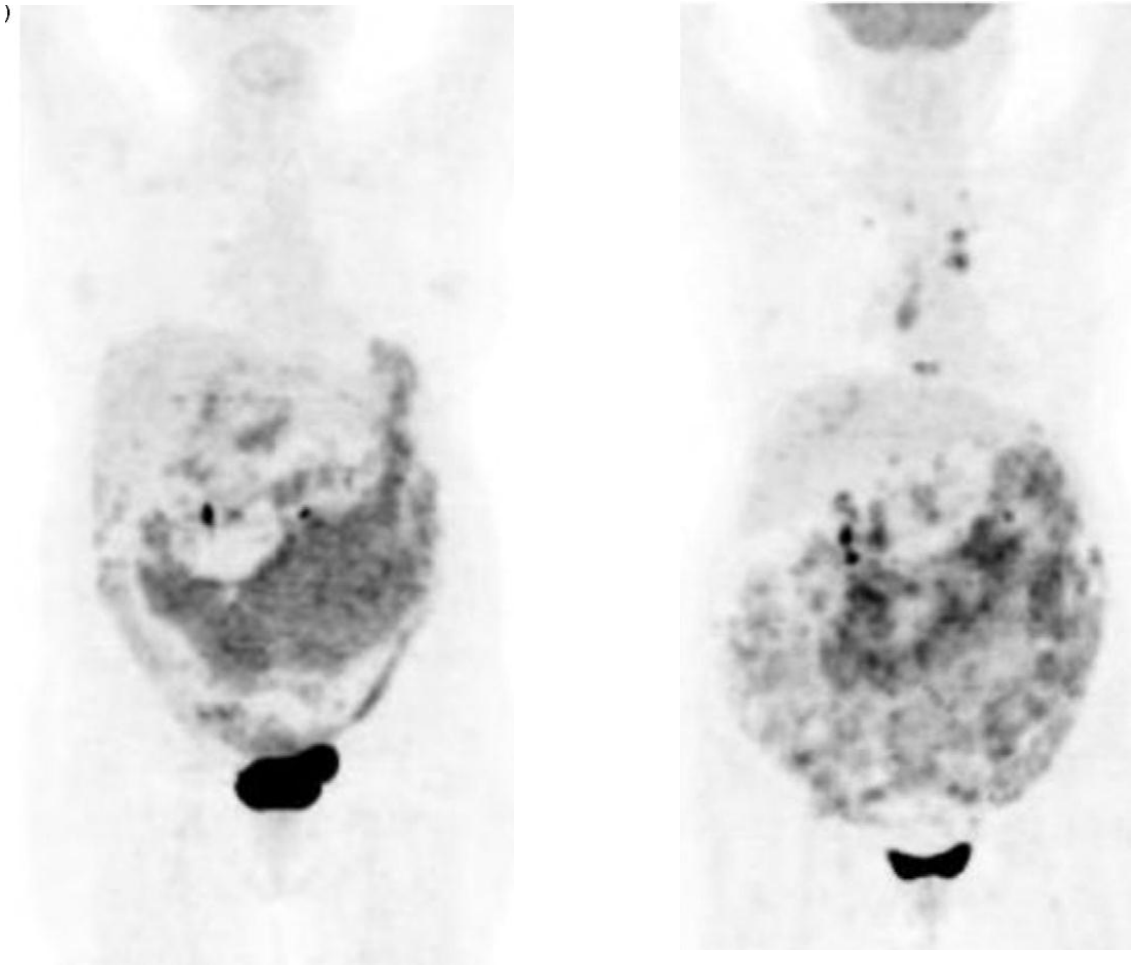



higher amount of PET/CT false negatives with nodules smaller than 0.5 cm. This is particularly true in upper abdomen quadrants including the hepatic dome (Q1), epigastrium (Q2) and left upper abdomen (Q3).

# PET/CT for detection of Peritoneal carcinomatosis

Pfannenberg et al, Annals of Surg Oncol 2009

# PET/CT for detection of Peritoneal carcinomatosis



# PET for initial staging Ovarian cancer

E.J. Nam et al. / Gynecologic Oncology 116 (2010) 389–394

**Table 2**
Sensitivity, specificity, positive predictive value (PPV), and negative predictive values (NPV) in PET/CT, Doppler US, and CT or MRI in evaluating ovarian and adnexa, extra-ovarian pelvis, and abdomen and beyond lesions.

| Anatomical region | Validity parameters | PET/CT (%) | CT or MRI (%)[a] | *P* value | Doppler US (%) | *P* value |
|---|---|---|---|---|---|---|
| Ovaries and adnexa | Sensitivity | 97.9 | 95.2 | 0.391 | 89.7 | 0.045 |
| | Specificity | 73.7 | 45.5 | 0.050 | 53.3 | 0.125 |
| | PPV | 90.2 | 83.3 | 0.247 | 83.3 | 0.191 |
| | NPV | 93.3 | 66.7 | 0.153 | 66.7 | 0.016 |
| Extra-ovarian pelvis and abdomen | Sensitivity | 94.6 | 94.1[a] | 0.604 | | |
| | Specificity | 82.8 | 71.4[a] | 0.900 | | |
| | PPV | 87.5 | 94.1[a] | 0.144 | | |
| | NPV | 92.3 | 71.4[a] | 0.505 | | |
| Lymph nodes | Sensitivity | 83.8 | 62.5 | 0.074 | | |
| | Specificity | 92.6 | 83.6 | 0.113 | | |
| | PPV | 81.6 | 60.0 | 0.083 | | |
| | NPV | 93.6 | 85.0 | 0.097 | | |

[a] MR imaging was adequate for analyzing pelvis and retroperitoneal lesion, not for abdominal implants. Therefore, comparison of extra-ovarian pelvis and abdomen lesion was made between PET/CT and CT.

# Detection of recurrence – Ovarian Cancer

- High likelihood of relapse after initial therapy especially in locally advanced stages (≥ IIB)
  - 75% of the clinical responders
  - 50% of pCR
- Cure rates after salvage therapy limited
  - Clinical FU and CA-125
  - Imaging on indication
  - Detection of recurrent disease eligible for secondary cytoreductive surgery

# Detection of recurrence – Ovarian Cancer PET results

**Table 5.** Diagnostic reliability of FDG-PET in the detection of recurrent disease in patients with epithelial ovarian cancer

| Author | Patients (*n*) | SE (%) | SP (%) | PPV (%) | NPV (%) |
|---|---|---|---|---|---|
| Kubik-Huch *et al.*[85] | 10 | 100 | 50 | 89 | 100 |
| Yen *et al.*[117] | 24 | 91 | 92 | | |
| Chang *et al.*[118] | 28 | 95 | 87 | | |
| Torizuka *et al.*[119] | 25 | 80 | 100 | 100 | 55 |
| Takekuma *et al.*[120] | 29 | 85 | 100 | 100 | 43 |
| Nakamoto *et al.*[121] | 12 | 80 | 50 | 89 | 33 |

**Table 3.** Diagnostic reliability of CT in the detection of persistent disease in patients with epithelial ovarian cancer undergoing second-look surgery

| Author | Patients (*n*) | SE (%) | SP (%) | PPV (%) | NPV (%) |
|---|---|---|---|---|---|
| Clarke-Pearson *et al.*[77] | 46 | 32 | 77 | 79 | 30 |
| Silverman *et al.*[78] | 48 | 40 | 99 | 96 | 87 |
| Reuter *et al.*[79] | 35 | 84 | 88 | 89 | 83 |
| De Rosa *et al.*[80] | 58 | 47 | 87 | 84 | 53 |
| Topuz *et al.*[81] | 52 | 50 | 100 | 100 | 76 |
| Cho *et al.*[82] | 21 | 54 | 99 | 97 | 91 |
| Picchio *et al.*[83] | 25 | 70 | 83 | 89 | 59 |

# Detection of recurrence – Ovarian Cancer PET/CT results

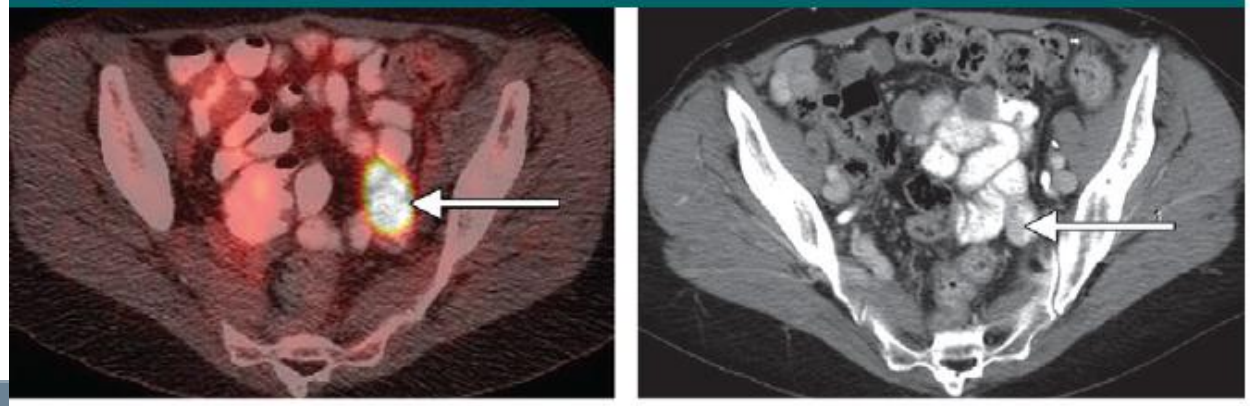
Biilici et al



**Table 3** FDG PET/CT results in the detection of recurrent ovarian cancer in relation to indications for the FDG PET/CT scan

| Indication | No. (%) of patients | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) | Median CA-125 level (U/ml) | Median follow-up (months) |
|---|---|---|---|---|---|---|---|---|
| Elevated CA-125 level and negative or indeterminate CT scan | 21(35) | 95 | NA | 95 | NA | 90.4 | 208 | 30.6 |
| Elevated CA-125 level and abnormal CT scan | 17(28.3) | 94.1 | NA | 100 | NA | 94.1 | 137.6 | 24.4 |
| Clinical symptoms and normal CA-125 level with abnormal CT scan | 18(30) | 100 | 100 | 100 | 100 | 100 | 13.4 | 26.9 |

**Figure 2**



a. b.

# PET/CT in Ovarian Cancer Conclusions

- DD diagnosis of ovarian masses

  - Limited value

- Primary staging

  - Sensitivity for peritoneal carcinomatosis too low

  - Only in equivocal CT cases, exclusion LN involvement of stage IV disease

- Detection of recurrence

  – Technique of Choice in in case of clinical symptoms or rising CA-125 levels with normal or equivocal CT findings.

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