



IL TUMORE DELLA MAMMELLA A FE: STATO DELL'ARTE E INNOVAZIONE

Sabato 8 Giugno 2013

Aula Magna Nuovo Arcispedale S. Anna
Cona, Fe

IMAGING FUNZIONALE: PET e PEM

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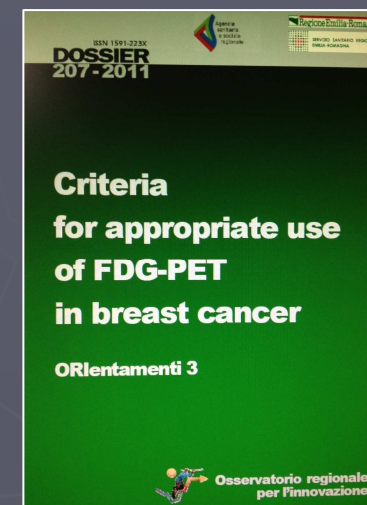


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Regione Emilia-Romagna

Dossier n. 207/2011 - Criteria for appropriate use of FDG-PET in breast cancer. Orientamenti 3



Diagnosi di tumore primitivo della mammella - **inappropriato**

Stadiazione N del tumore primitivo della mammella - **inappropriato**

Stadiazione M del tumore localmente avanzato della mammella - **incerto**

Valutazione della risposta precoce al trattamento neoadiuvante - **incerto**

Valutazione della risposta alla terapia neoadiuvante al termine del trattamento - **inappropriato**

Diagnosi e stadiazione di sospetta recidiva locale e a distanza - **incerto**

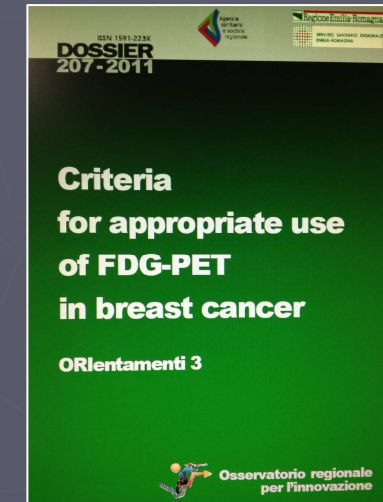


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... sulla PET non vè certezza ...

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[Comparison of \(18F\)FDG-PET-CT and bone scintigraphy for detection of bone metastases in breast cancer patients. A meta-analysis.](#)
1. Rong J, Wang S, Ding Q, Yun M, Zheng Z, Ye S.
Surg Oncol. 2013 Jun;22(2):86-91. doi: 10.1016/j.suronc.2013.01.002. Epub 2013 Feb 8.
PMID: 23726506 [PubMed - in process]
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[Radionuclide methods for breast cancer staging.](#)
2. Lee JH.
Semin Nucl Med. 2013 Jul;43(4):294-8. doi: 10.1053/j.semnuclmed.2013.04.001.
PMID: 23725991 [PubMed - in process]
[Related citations](#)

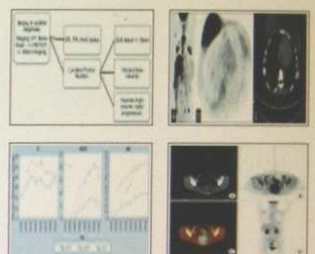
[Fluorine-18 Fluorodeoxyglucose Positron Emission Tomography-Computed Tomography in Monitoring the Response of Breast Cancer to Neoadjuvant Chemotherapy: A Meta-Analysis.](#)
3. Mghanga FP, Lan X, Bakari KH, Li C, Zhang Y.
Clin Breast Cancer. 2013 May 25. doi:pii: S1526-8209(13)00048-7. 10.1016/j.clbc.2013.02.003. [Epub ahead of print]
PMID: 23714689 [PubMed - as supplied by publisher]
[Related citations](#)

[Dual time point 2-deoxy-2-¹⁸F-fluoro-d-glucose PET/CT. Nodal staging in locally advanced breast cancer.](#)
4. García Vicente AM, Soriano Castrejón A, Cruz Mora MA, Ortega Ruiperez C, Espinosa Aunión R, León Martín A, González Ageitos A, Van Gómez López O.
Rev Esp Med Nucl Imagen Mol. 2013 May 23. doi:pii: S2253-654X(13)00044-9. 10.1016/j.remnm.2013.03.005. [Epub ahead of print]
PMID: 23707190 [PubMed - as supplied by publisher]
[Related citations](#)

[A new method for apparent diffusion coefficient measurement using sequential ¹⁸F-FDG PET and MRI: correlation with histological grade of invasive ductal carcinoma of the breast.](#)
5. Byun BH, Noh WC, Lim I, Lee SS, Cho AR, Park JA, Kim KM, Kim HA, Kim EK, Kim BI, Choi CW, Lim SM.
Ann Nucl Med. 2013 May 23. [Epub ahead of print]
PMID: 23700260 [PubMed - as supplied by publisher]
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Neoadjuvant chemotherapy in breast cancer prediction of pathologic response [Radiology. 2013]

Prognostic impact of (18)FDG-PET-CT findings clinical stage III and IIB [J Natl Cancer Inst. 2013]

Whole-body FDG PET/CT is more accurate than conventional [Eur J Nucl Med Mol Imaging. 2013]

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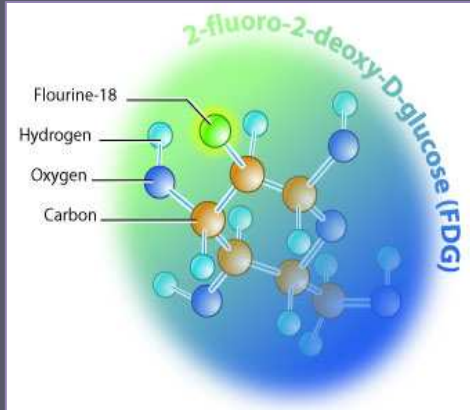
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Genotyping analysis and 18FDG uptake in breast cancer patients [J Exp Clin Cancer Res. 2013]

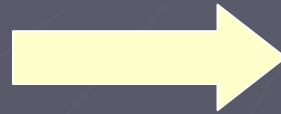
Skeletal muscle metastases from breast cancer: two case reports [J Breast Cancer. 2013]

False Positive 18F-FDG Uptake in Mediastinal Lymph Nodes Detected with PET-CT [Case Rep Med. 2013]

FDG PET/CT: aspetti generali



*1 mCi ogni
10 kg peso*

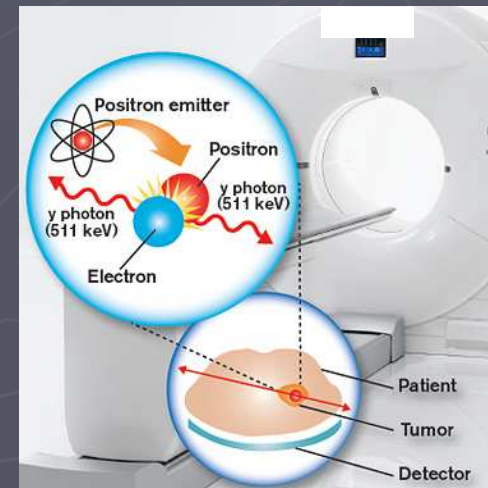
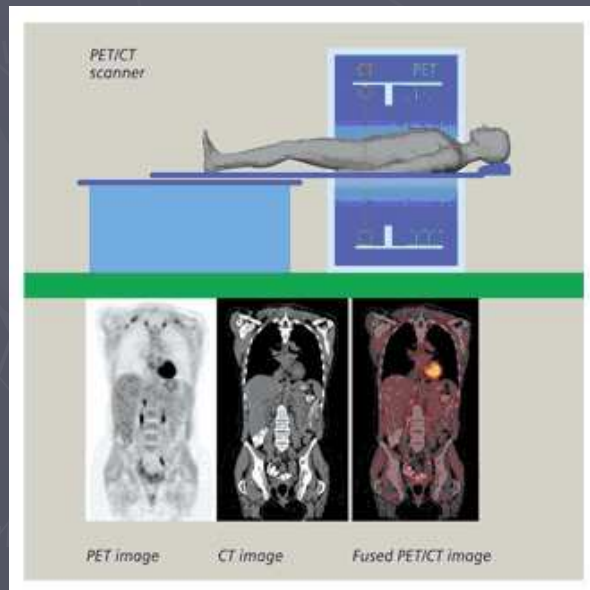


Emittore di positroni
Emivita: 120'



- ✓ Digiuno
- ✓ Glicemia ok

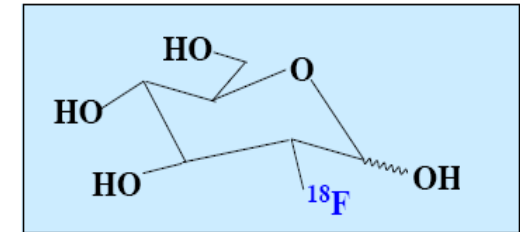
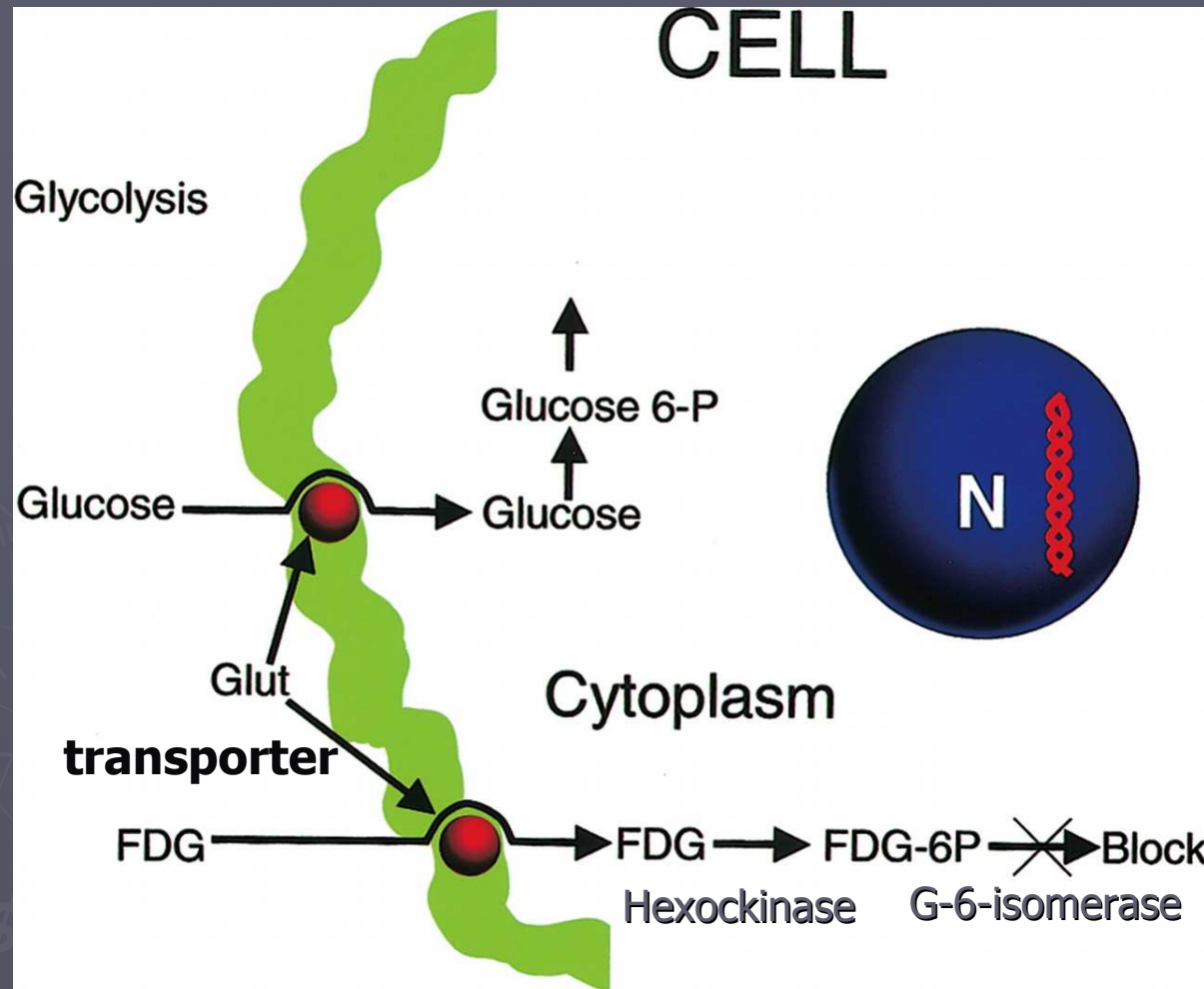
Attesa di circa 60'



*Acquisizione
PET e CT
circa 15'*

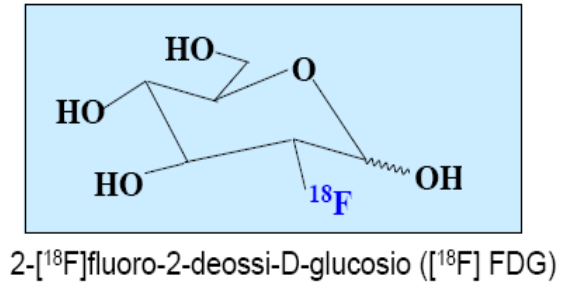
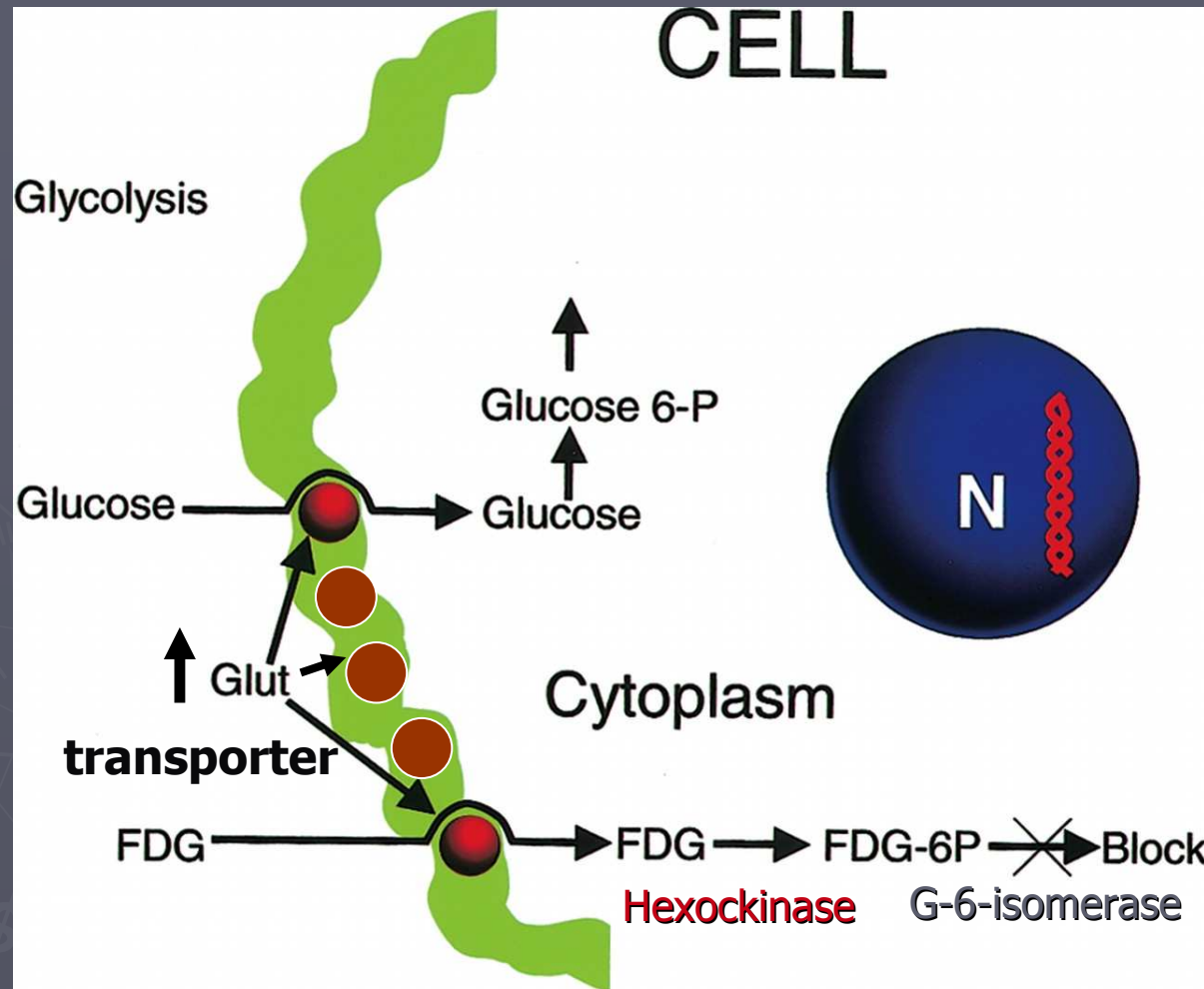
FDG PET/CT: distribuzione fisiologica

18F-FDG: Meccanismo di internalizzazione nella cellula tumorale



2-[¹⁸F]fluoro-2-deossi-D-glucosio ([¹⁸F] FDG)

18F-FDG: Meccanismo di internalizzazione nella cellula tumorale



SUV: Standardized Uptake Value

$$\text{SUV} = \frac{\text{Maximum radioactivity of ROI (nCi/ml)}}{\text{Intravenous radioactivity (nCi/ml) / weight (g)}}$$

(Region of Interest, ROI)

Sottostima del SUV quando la lesione o il residuo tumorale è piccolo (*effetto di volume parziale*)

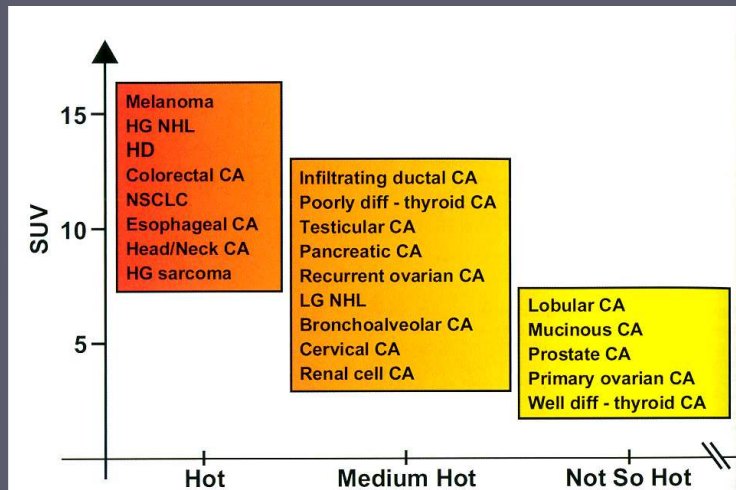


Figure 3. The degree of FDG uptake varies between different cancer types. Note that high grade (HG) tumors generally exhibit higher FDG uptake than low grade (LG) tumors. For instance, poorly differentiated (diff) thyroid cancer shows moderately or severely increased FDG uptake while well differentiated thyroid cancer is frequently low in FDG uptake. Functional features of tumors also determine FDG uptake. For instance, mucinous carcinoma (CA) generally exhibit very low FDG uptake. Tumor morphology is also an important predictor FDG uptake. For instance, primary ovarian cancer frequently consists of large cystic portions resulting in poor FDG uptake.

Abbreviations: NHL: Non-Hodgkin Lymphoma; HD: Hodgkin's Disease.

Mean SUV values

Brain	6.0-8.0
Pituitary	if max >5.0, look for bilat adr hyperplasia or breast uptake
Tonsils	3.5 (palatine), 3.1 (lingual)
Soft palate	3.1
Salivary glands	variable (sublingual>submand>parotid)
Vocal cords	variable (post cricoarytenoid>cords)
Thyroid	1.3 (focal uptake →30%CA; focal uptake>4.2 w/ hypodense nodule on CT→90%CA)
Lung	0.7 (>1.8 is abnl)
Mediastinum	1.5-2.5 (>2.5 is abnl)
Malignant effusion	2.2-2.6
Thymus	1.8 (max≤3.8; CA>5.0)
Eso (distal)	≤4.0
Liver	2.5-3.0
Spleen	1.9
Adrenal	Adenoma=HU<10; SUV≤3.1 (SUV ratio ≤2.5 compared to liver)
BM	1.0 (activity > than liver is considered abnl)
Spinal cord	2.1 (physio c-spine, T11/12, L1 level esp in winter; focal increased uptake=spondylotic vs XRTmyelopathy)
Spinal compress fx	3.9+/-1.5 for malig and 1.9+/-1.0 for b9
Breast	0.5-1.5 (max<2.5); axillary mets ≥2.3
Testes	2.2 (max<5.7; normally decreases w/ age)
Septic thrombosis	>3.8max
Bladder	30-60

Organ	Typical SUV
Lung	0.5
Muscle	1.0
Liver	2-4
Heart	0.5-5
Brain	3-10
Neoplasm or Infection	1-50
Bladder/Urine	5-50

SUV = parametro per valutare l'aggressività del tumore

Uptake dell'FDG nel tumore mammario correla con istologia e caratteristiche biomolecolari del tumore

Ca duttale infiltrante > Ca lobulare infiltrante

Grade 3 > Grade 1-2 *

Ki67 status correla con FDG uptake °

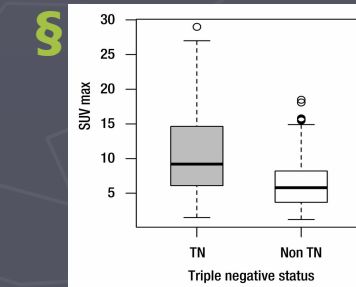
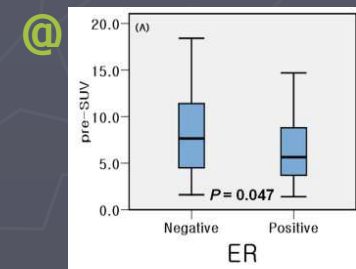
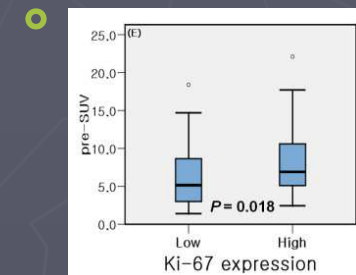
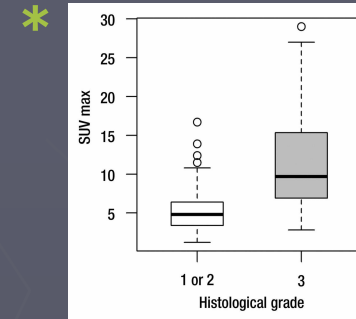
ER status correla con FDG uptake @

Rec. progestinici negativi → ++ FDG uptake

HER2/neu non correla con + FDG uptake

TN status correla con FDG uptake §

p53 → ++ FDG uptake

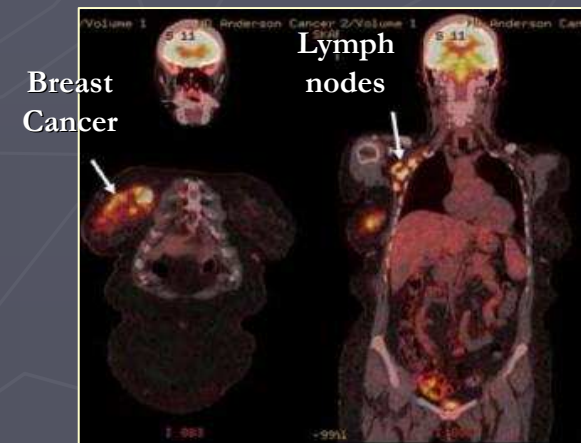


FDG PET/CT: ha un ruolo nella D.D. tra patologia mammaria benigna e maligna?

1. Mastite granulomatosa → + FDG uptake
2. Fibroadenoma → - FDG uptake
3. Mammella densa mostra alta fissazione dell'FDG rispetto a mammella non densa
4. La mammella durante l'allattamento mostra elevata captazione dell'FDG
5. Infezione acuta o cronica (mastite) e mastite emorragica post chirurgica evidenzia un incremento della captazione dell'FDG.

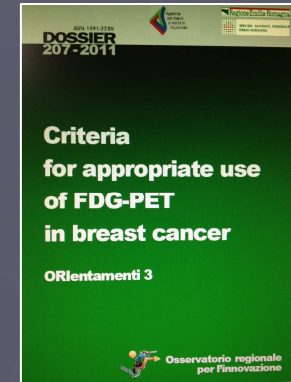
PET/CT? Individua la massa ma non è in grado di definirne la natura;

"Dual-time imaging": uptake FDG sembra incrementare nel tempo in caso di malignità; → "time consuming"



Criteria per un uso appropriato della FDG-PET nel tumore della mammella

1. Diagnosi di tumore primitivo della mammella
2. Stadiazione N del tumore primitivo della mammella
3. Stadiazione M del tumore localmente avanzato della mammella
4. Valutazione della risposta precoce al trattamento neoadiuvante
5. Valutazione della risposta alla terapia neoadiuvante al termine del trattamento
6. Diagnosi e stadiazione di sospetta recidiva locale e a distanza



Diagnosi di tumore primitivo della mammella

Inappropriato l'uso della FDG PET per assenza di ruolo diagnostico.

PERCHE'?

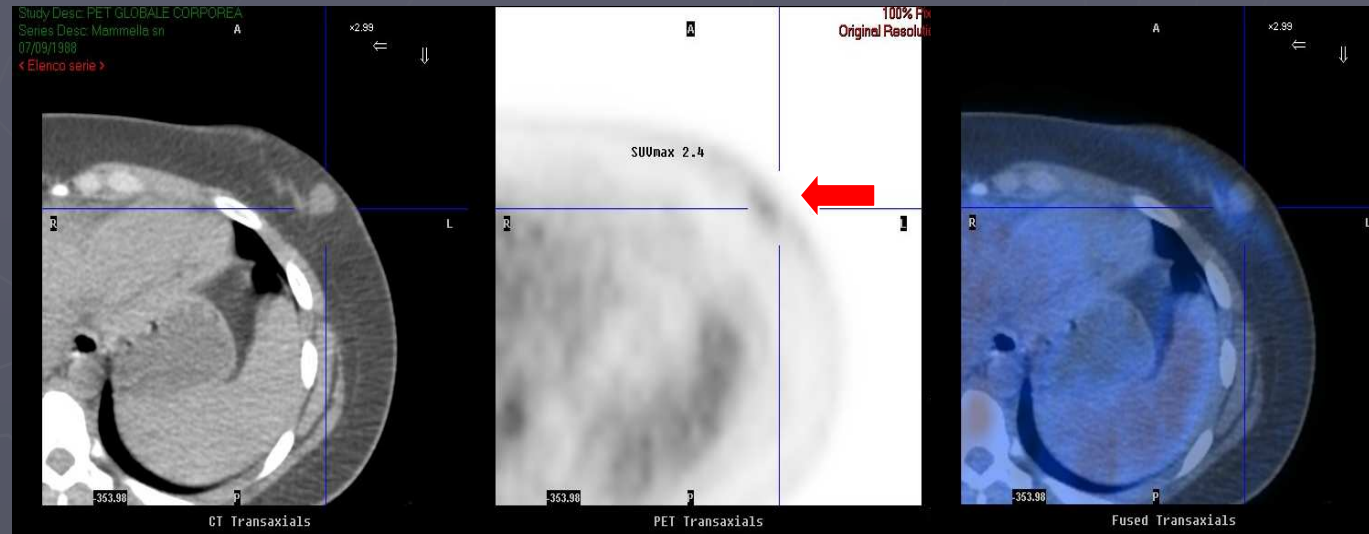
- ✓ MMX, US, MRI – istologia o citologia ("gold standard")
- ✓ Potere di risoluzione del tomografo PET/CT "last generation" è di 5-6 mm con capacità di evidenziare una lesione quando ha dimensioni ≥ 1 cm
- ✓ La localizzazione del tumore non dipende solo dalla dimensione ma anche dal grado di avidità dell'FDG, dal rapporto target/background dell'FDG, dall'istotipo (tumore ben differenziato non capta) o dalla lenta crescita, nonché dal movimento (respiro).
- ✓ Quindi una lesione inferiore ad 1 cm può essere rilevata se certe condizioni lo permettono.
- ✓ Situazione particolare e non così rara da incontrare:
***Incidentaloma mammario** – Imaging PET eseguito per altro motivi che mette in evidenza un aumento del metabolismo glucidico anomalo a livello mammario che richiede un approfondimento radiologico.*



*"...FDG uptake **incidentally** detected during a PET performed for other reasons ... it is necessary to explore it with conventional imaging and biopsy because of the high risk of malignancy ..."*

Litmanovich et al., Eur J Nucl Med 2009

11/10/2012



**donna, 25 anni, LH
stadiazione pre
CHT (ABVD)**

Individuazione di addensamento mammario sn - alla PET SUV max 2.4

Panareo et al. Work in progress

Approfondimento US con TRU-CUT

11/10/2012



**donna, 25 anni, LH
stadiazione pre
CHT (ABVD)**



**Nodulo 18 x 16 x 13 mm QIE mammella sinistra
sospetto per malattia linfomatosa mammaria**

Esame istologico – tu. Filloide

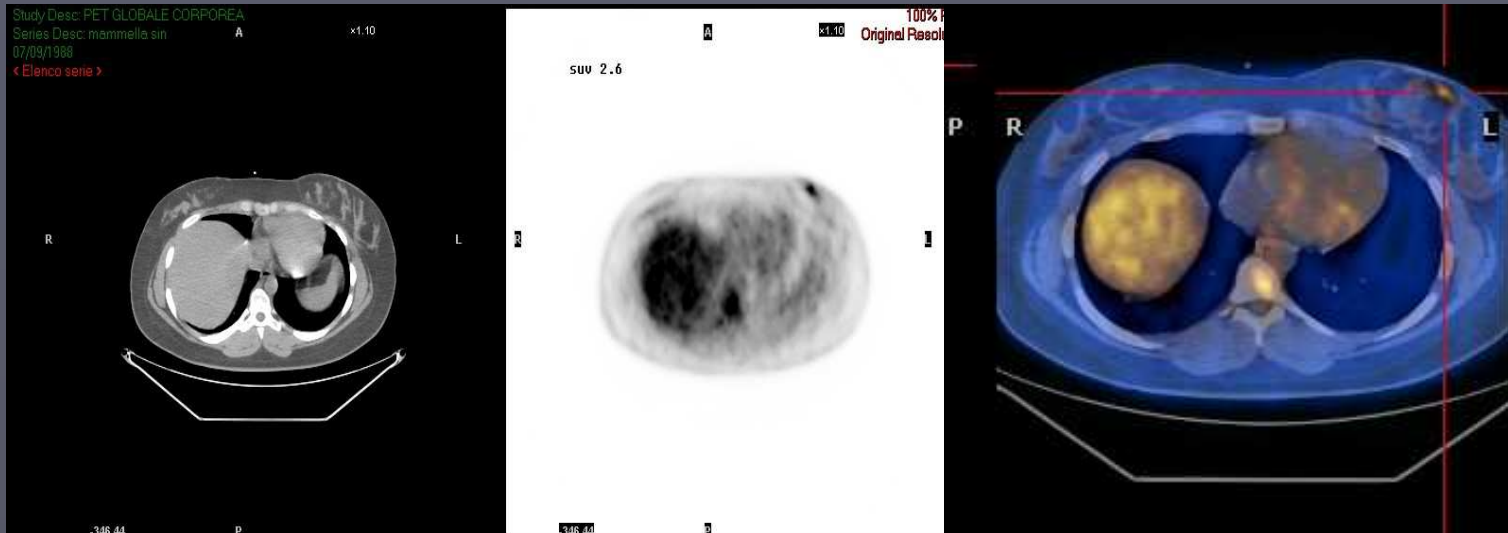
Panareo et al. Work in progress



Conferma della benignità

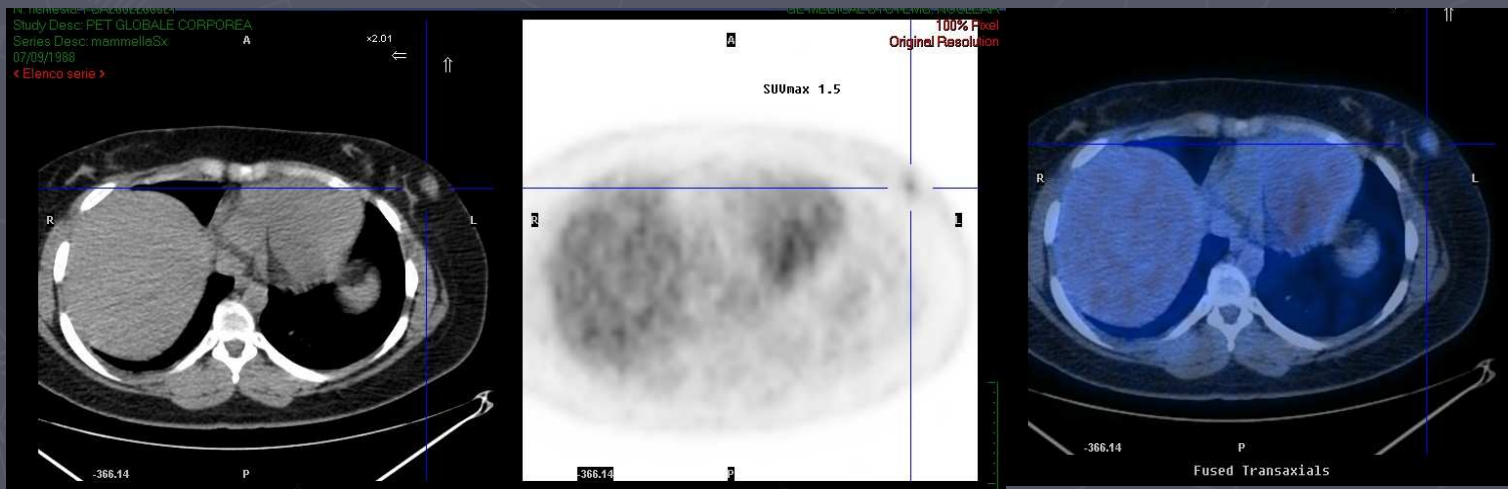
17/12/2012

SUV Max 2.6



17/04/2013

SUV Max 1.5



LH: RC dopo 6 cicli ABVD

Panareo et al. Work in progress

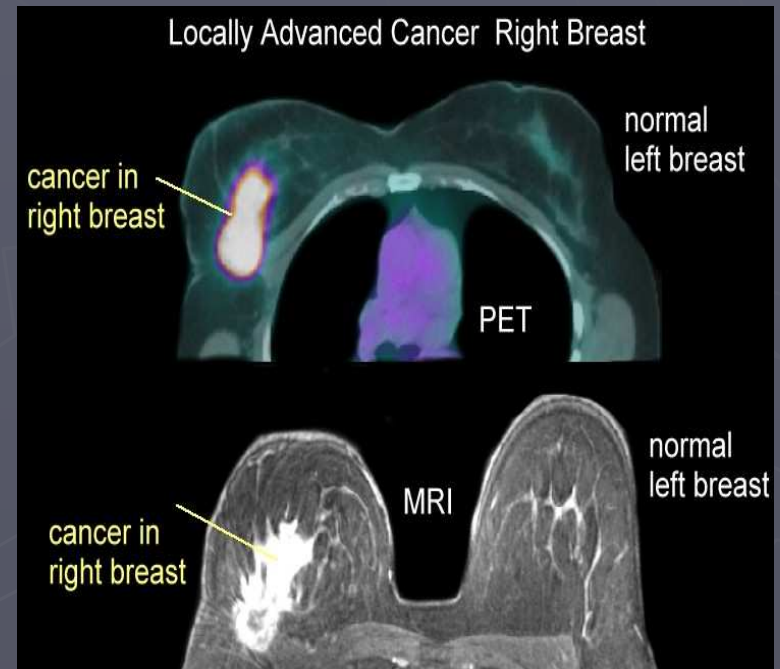
E' utile la FDG PET/CT nella definizione della multifocalità del tumore mammario?

Classificazione del T
(multifocalità, multicentricità)

PET/CT = 54%

MRI = 77%

$p = .001$



Heuser et al. J Nucl Med 2008

La performance della PET nella diagnosi di tumore mammario migliora utilizzando un tomografo dedicato: **PEM or PEM/MRI**

FDG PET/CT: confronto con LNS e staging N ascellare in "early breast cancer"

La PET/CT non è sostitutiva della tecnica del LNS perché non in grado di rilevare micrometastasi linfonodali (limite di risoluzione spaziale);

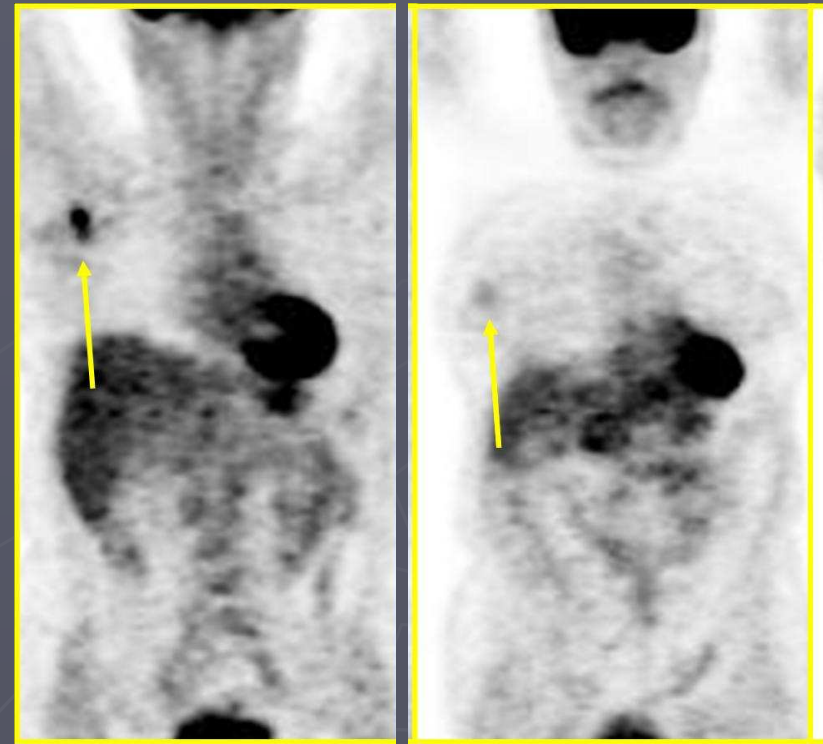
“ *in a study involving 236 patientes with clinicall negative findings for axillary involvement who underwent FDG PET prior to sentinel node biopsy, only **37%** with positive results of SLN biopsy had positive findings at PET*”

Veronesi et al., Ann Oncol 2007

In caso di uptake linfonodale dell'FDG positivo (= altamente suggestivo di malignità con VPP 80% - valore prognostico) alcuni autori consigliano la linfadenectomia; altra possibilità è di eseguire una US con FNAC, se citologia positiva si può evitare la tecnica del LNS.

PET and "CUP syndrome" (Cancer Unknown Primary)



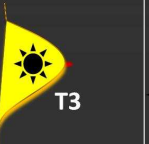
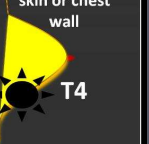
- ▶ Definition: metastases of axillary lymph nodes without primary breast tumor detection.
- ▶ Why PET for CUP Syndrome? ^{18}F FDG PET is useful for axillary lymph node staging and to detect the primary breast tumor, in particular when conventional imaging are negative or doubtful.

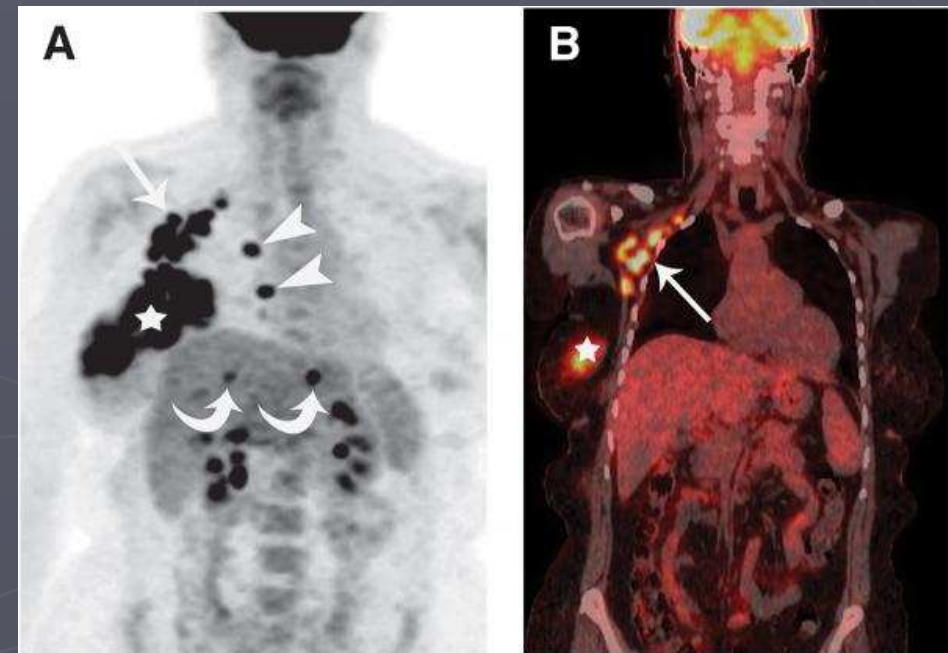


^{18}F -FDG PET

Stadiazione M del tumore localmente avanzato della mammella

Ruolo incerto della FDG PET nel senso che non è stato raggiunto un consenso unanime nell'indicare l'esecuzione della PET in tumori avanzati (T3-T4 e/o N2-N3) con lo scopo di indirizzare verso ulteriori indagini diagnostiche.

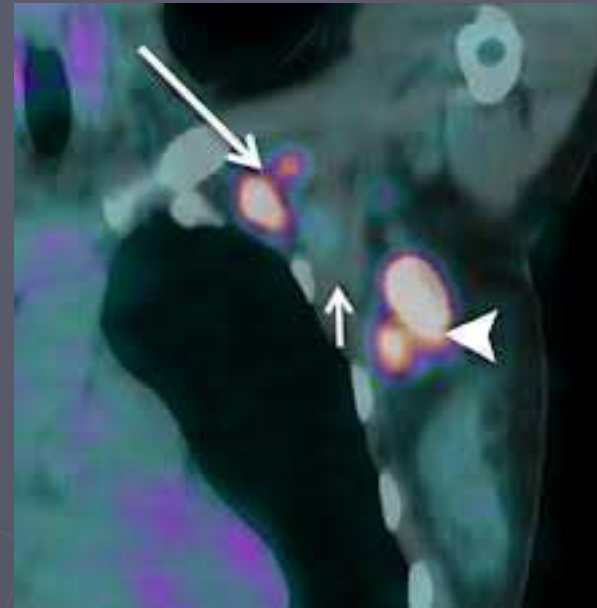
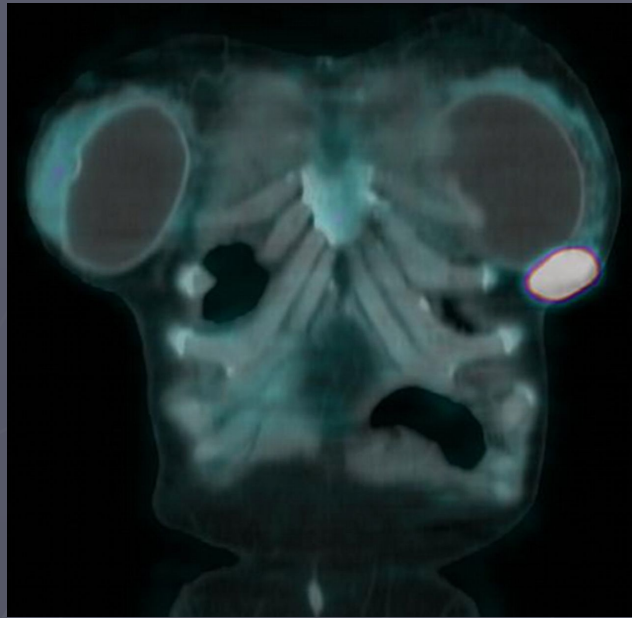
Tumor size	Tumor size < 2 cm	Tumor size 2-5 cm	Tumor size > 5 cm	Tumor extends to skin or chest wall
T	 T1	 T2	 T3	 T4
Lymph Nodes N	N0 No lymph node metastasis	N1 Metastasis to ipsilateral, movable, axillary LNs	N2 Metastasis to ipsilateral fixed axillary, or IM LNs	N3 Metastasis to infraclavicular/supraclavicular LN, or to axillary and IM LNs
Metastasis M	M0 No distant metastasis	M1 Distant metastasis		



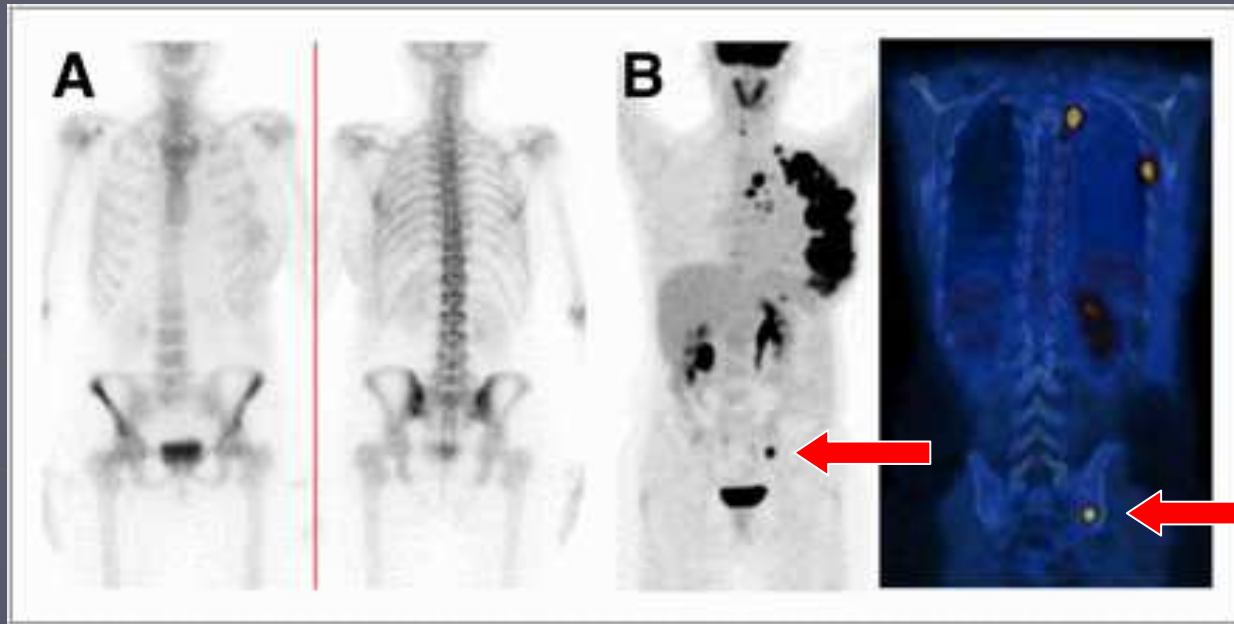
Study/Year/Type	Setting	No. of Patients	PET/CT Imaging	Conventional Imaging, with Other Modalities Performed	Effect of PET/CT Results (%)*			
					Detection of Unknown Node Metastases†	Detection of Unsuspected Distant Metastases	Modification in Initial Staging	Modification in Treatment Plan
Groheux et al (40)/2008/P	Stage II–III breast cancer	39	WB PET performed approximately 60 min after FDG injection; low-dose nonenhanced CT	Mammography, with or without breast MR imaging; breast US; abdominal US, with or without abdominal CT; chest radiography or CT, bone scintigraphy	8	10	18	13
Heusner et al (27)/2008/R	T1–T3 noninflammatory breast cancer	40	WB PET performed approximately 60 min after FDG injection plus additional breast PET acquired 110 min after injection; contrast-enhanced CT	Breast MR imaging, axillary US, chest radiography, abdominal US, bone scintigraphy	7.5	7.5	NA	12.5
Fuster et al (39)/2008/P	Large (T category > 3 cm) noninflammatory breast cancer	60	WB PET performed approximately 60 min after FDG injection; nonenhanced CT	Breast MR imaging, chest contrast-enhanced CT, liver US, bone scintigraphy	5	8.5	42‡	6.5
Yang et al (38)/2008/R	Inflammatory breast cancer	24	WB PET performed approximately 60–90 min after FDG injection; nonenhanced CT	Mammography, breast US, and MR imaging	25§	38	NA	NA
Carkaci et al (37)/2009/R	Inflammatory breast cancer	41	WB PET performed approximately 60–90 min after FDG injection; nonenhanced CT	Mammography, breast US, or MR imaging; bone scintigraphy, chest radiography, chest and abdominal CT	15 for supraclavicular area; 22 for internal mammary basin§	17	NA	NA
Alberini et al (25)/2009/P	Inflammatory breast cancer	59	WB PET performed approximately 60 min after FDG injection; low-dose nonenhanced CT	Chest radiography, abdominal US, bone scintigraphy; if necessary, additional CT investigations were performed	56§	31§	NA	NA
Aukema et al (41)/2010/P	Stage II–III breast cancer	60	WB PET performed approximately 60 min after FDG injection plus additional PET of the thorax, including breasts and axillae, with the patient in prone position; low-dose nonenhanced CT	Mammography, breast US, breast MR imaging	17	NA	17	12
Segaert et al (42)/2010/R	Stage IIB–III breast cancer	70	WB PET performed 75 min after FDG injection; contrast-enhanced CT performed during breath hold at expiration tidal volume	Chest radiography, liver US, bone scintigraphy, breast and axillary US	13, internal mammary basin	10	NA	NA

“Change of patient management – treatment plan: presurgical CHT and/or Radioterapy”

Groheux et al. Radiology 2013



61 anni, Carcinoma duttale infiltrante della mammella sx sottoposta dieci anni prima a chirurgia estetica con mastectomia bilaterale e protesi; prima della PET/CT il tumore fu classificato come **T2N2** (lesione di 45 mm a sx con N+ I livello ipsilaterale a livello ascellare); dopo PET/CT il tumore fu riclassificato **T2N3a** (captazione del tumore - SUV max 15.7 – uptake di un linfonodo ascellare I livello + uptake di linfonodo III livello - infraclavicolare)



Bone scan (A) e PET/CT (B) in paziente **T4bN3Mo** (stage IIIC) ER+, Prog-, HER2-, grado 3, Ca. duttale infiltrante della mammella sx. PET/CT evidenzia tumore primitivo mammario sx localmente avanzato con linfonodi ascellari e sopraclavicolari e numerose metastasi a distanza all'osso e alla pleura. Riclassificazione: **T4bN3cM1**

"It appears that FDG PET is complementary to bone scintigraphy, which remains the standard imaging procedure for surveying the skeleton for metastatic involvement"

Nakai et al. Eur J Nucl Med Mol Imag, 2005

Is better FDG-PET/(CT) or Bone Scan in the detection of bone metastases?

FDG-PET/(CT)

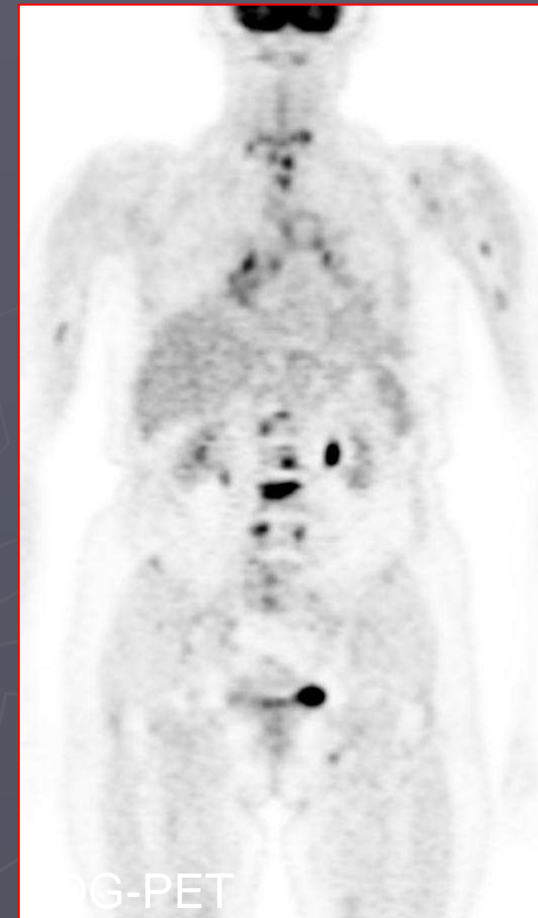
- ▶ Sensitivity 95%
- ▶ Specificity **95%**

Bone Scan

- ▶ Sensitivity 93%
- ▶ Specificity 79%

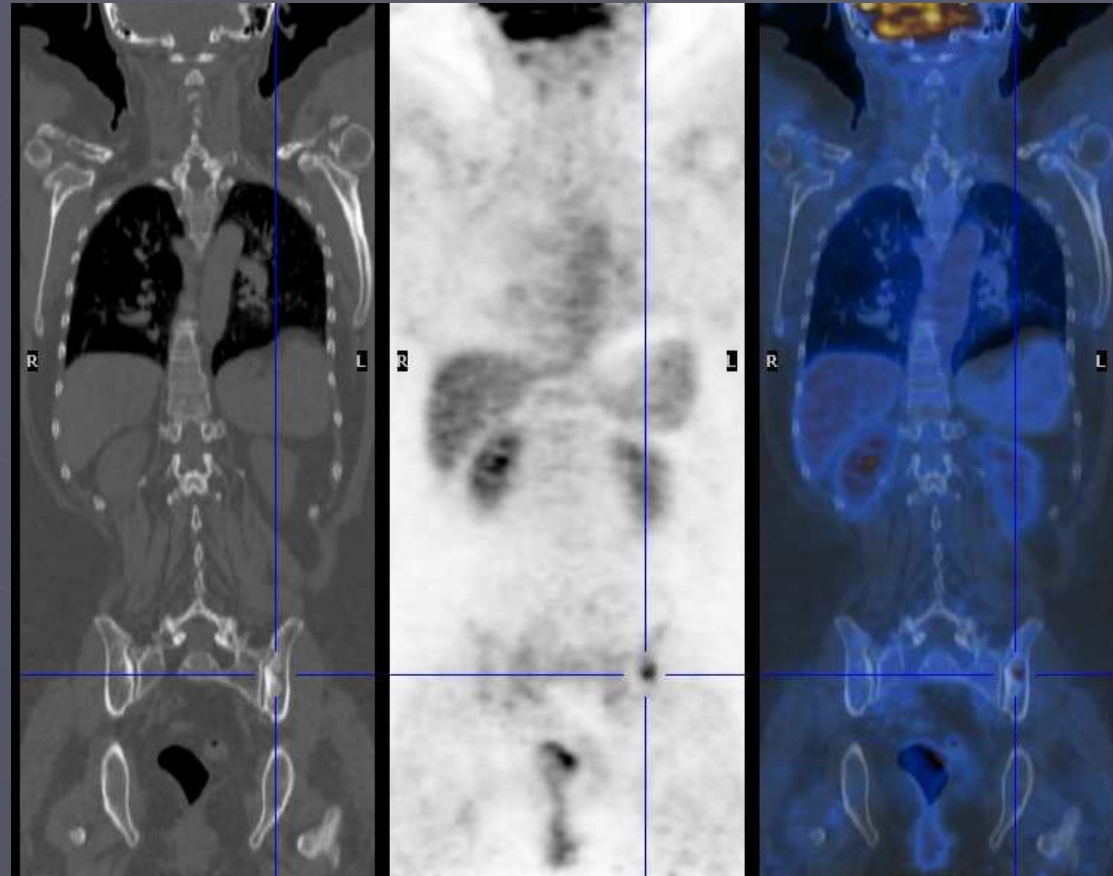
SPECT/CT → Specificity 92%

“FDG-PET seems to be better for osteolytic or mixed metastases detection than sclerotic metastases, bone scan detects osteoblastic lesions”

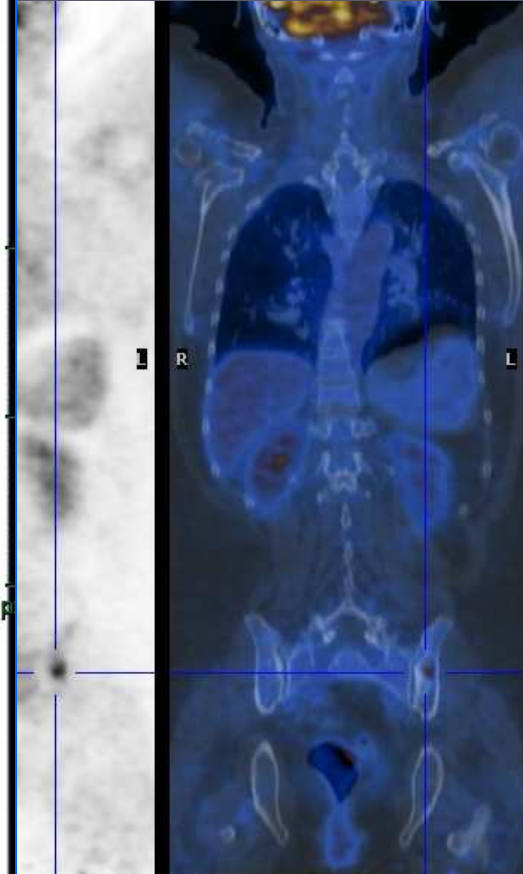
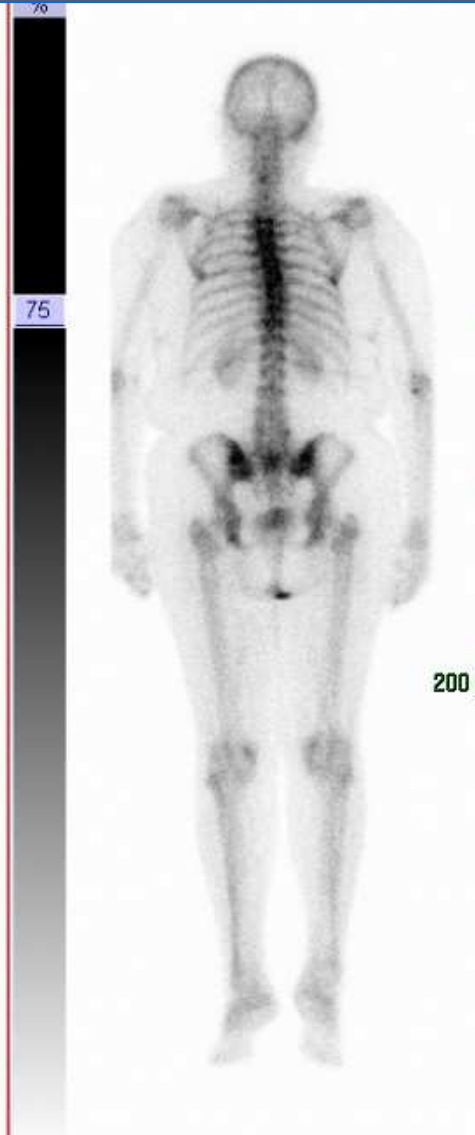


(Yang et al. J Cancer Res Clin Oncol 2002)

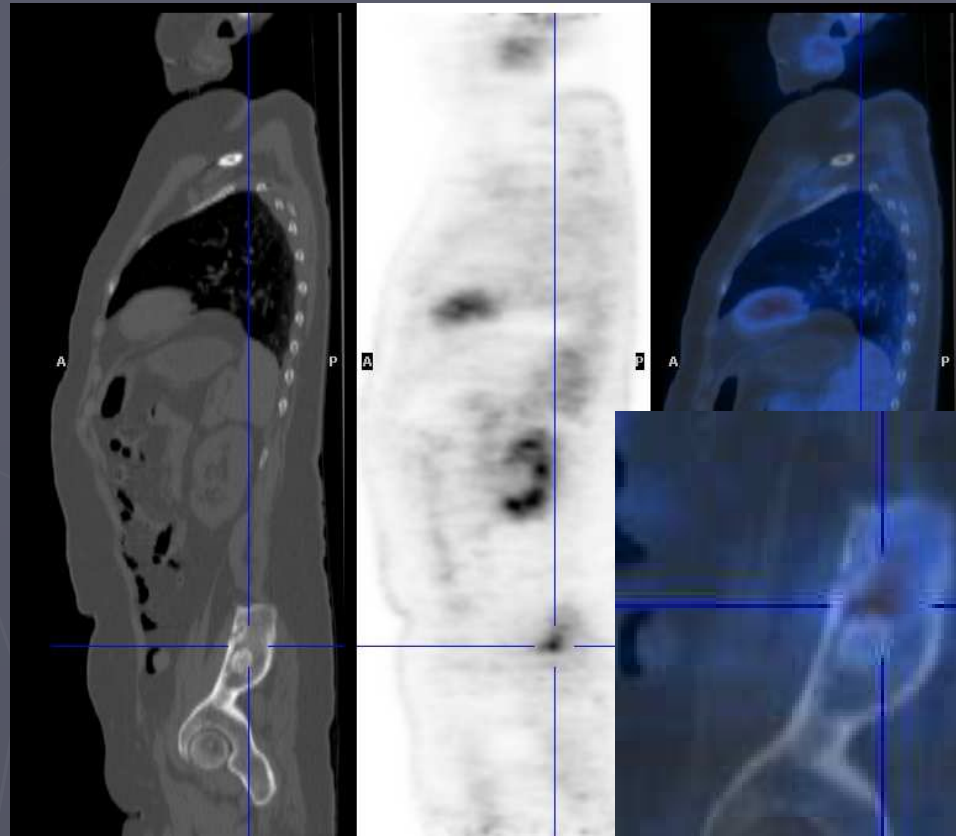
Ca 15.3 +++, Imaging convenzionale negativo, BS negativo



Ca 15.3 +++, Imaging convenzionale negativo, **BS negativo**



Ca 15.3 +++, Imaging convenzionale negativo, BS negativo



Lesione ossea ala iliaca sinistra SUV max 3.8

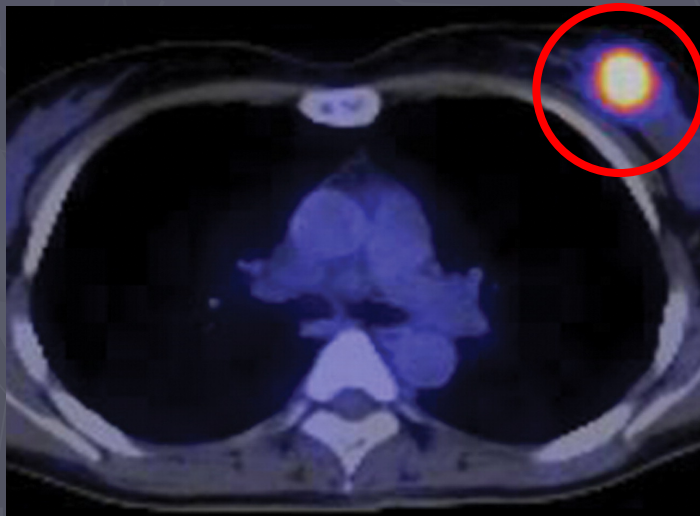
Az. Osp-Univ Ferrara

Valutazione della risposta precoce al trattamento neoadiuvante

Incerta l'appropriatezza della FDG PET/CT nella valutazione della risposta precoce al trattamento neoadiuvante nelle pazienti con tumore localmente avanzato o candidate alla mastectomia.

E' necessario un esame che possa correttamente identificare le pazienti che rispondono alla chemioterapia neoadiuvante.

FDG PET/CT



Before NAC - SUV max 7.2

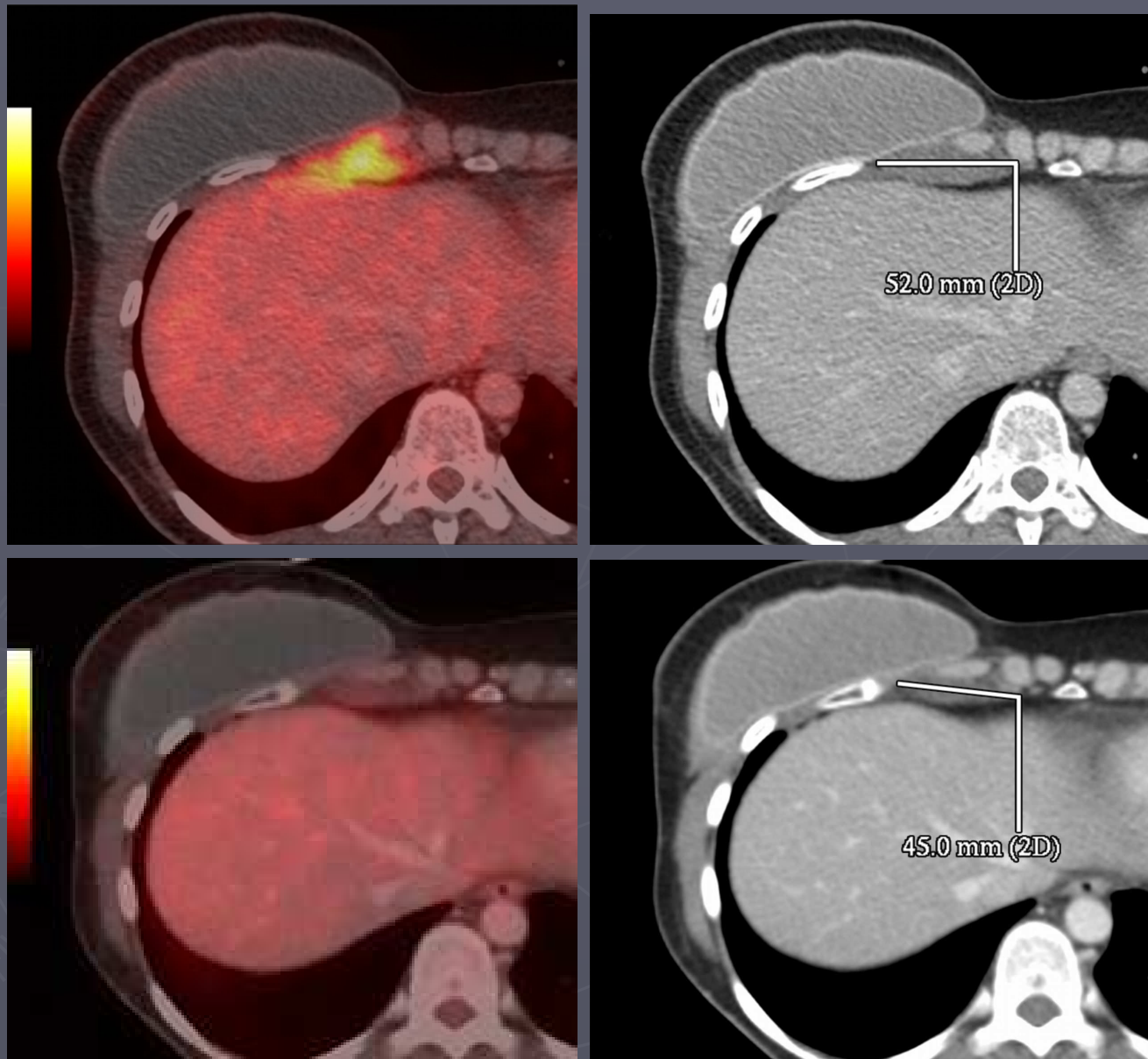


After II cycle of NAC - SUV max 1.2

Monitoring of EARLY treatment response during chemotherapy to see if the treatment in use will be effective

- ▶ Anatomic changes (diameter of lesion) are measurable by conventional imaging only several weeks after the beginning of therapy.
- ▶ FDG-PET is more effective than anatomic imaging in monitoring early treatment response, using serial SUV measurements. A rapid decrease in glucose metabolism in responders can be detected on PET as early as after 1-2 cycles of chemotherapy.

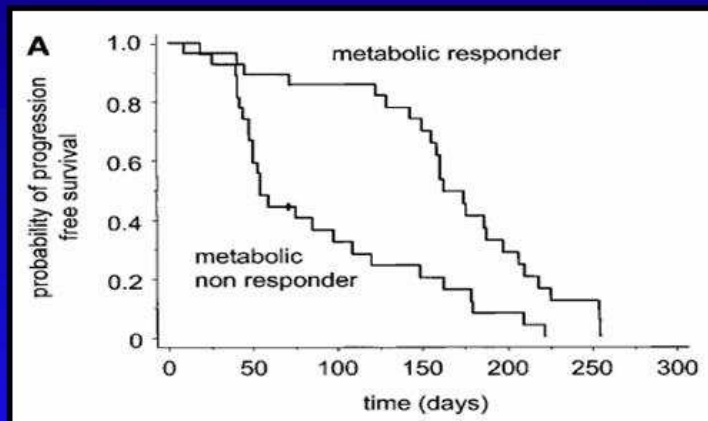
Risposta alla CHT: imaging funzionale o radiologico?



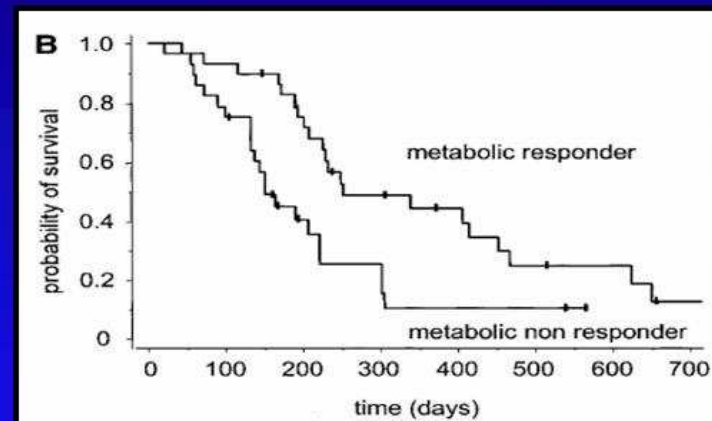
L'assenza di residuo tumorale conseguente a NAC è associato all'incremento della "disease free-survival" e della "overall survival".

Better Outcomes in PET Responders

Progression-Free Survival

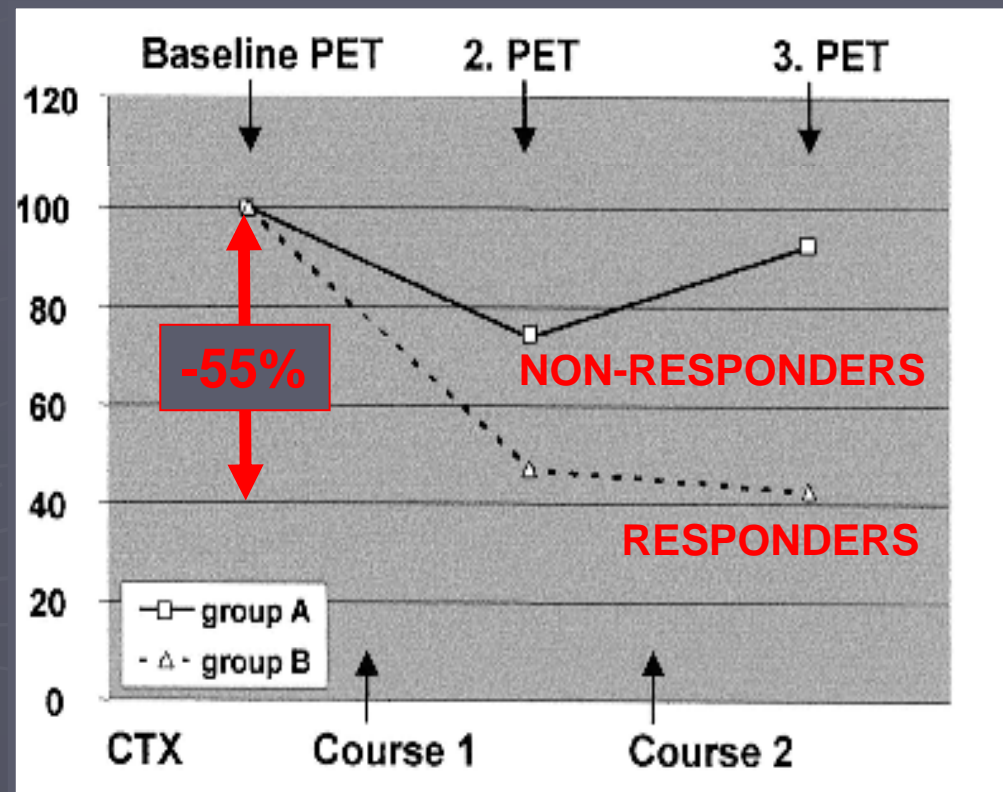


Overall Survival



Weber, Journal of Clinical Oncology, 21: 2651 – 2657, 2003

Early evaluation of treatment response by SUV



Quale il valore soglia del SUV (Δ SUV) per discriminare i responders dai non responders alla NAC?

- Tumor regression superior to 50%;
- No residual invasive tumor or only few scattered foci of microscopic residual tumor;
- ***Decrease of SUV more than 25%.***

Timing for the interim PET? After II cycle of NAC.

Low tumor metabolic activity (low SUV) at pretreatment could be an indicator of chemotherapeutic resistance.

La PET eseguita dopo due cicli di CHT ha diverse implicazioni:

- 1) indice di riduzione della massa tumorale che favorisce una chirurgia conservativa,
- 2) indice di risposta alla CHT;
- 3) indice di resistenza alla CHT.

Valutazione della risposta alla terapia neoadiuvante al termine del trattamento

Inappropriato: l'uso della FDG PET/CT per la valutazione della risposta alla terapia neoadiuvante al termine della stessa. Sebbene la risposta alla terapia pre-operatoria sia importante per decidere il successivo programma terapeutico, per le pazienti sottoposte a terapia al termine della CHT il risultato istopatologico ottenuto sul reperto chirurgico è il *gold standard*.

FDG PET imaging performed after completion of therapy allows confirmation of gross residual disease but does not allow exclusion of residual microscopic malignancy

Studies performed after the completion of chemotherapy have shown that while residual FDG uptake is predictive of residual disease, the absence of FDG uptake is not a reliable indicator of complete pathologic response.

PET and Chemotherapy

Monitoring of LATE therapy response

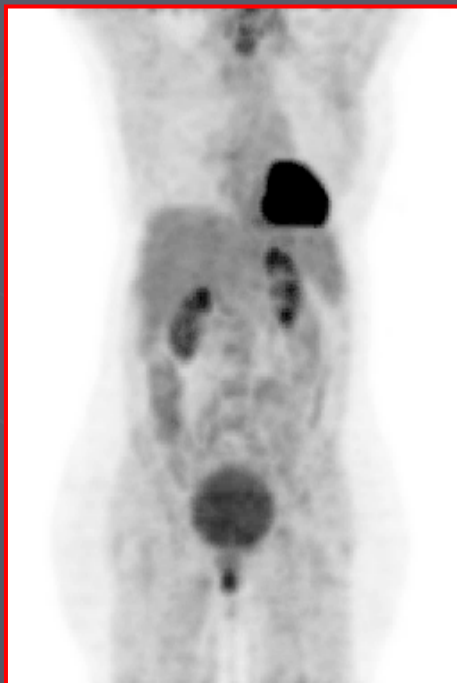
Ductal-invasive breast cancer pT2 pN1 M0, G3, ER+ PR+
11/1998 Mastectomy, Ch (CMF) and Rx,



June 2000

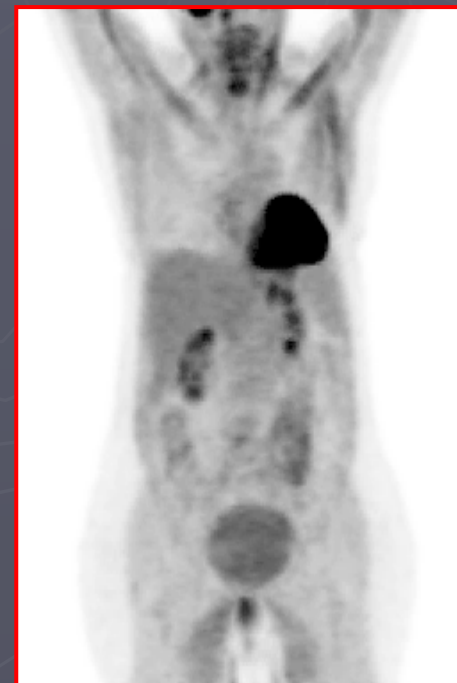
Liver & bone mets

↑ CA 15-3



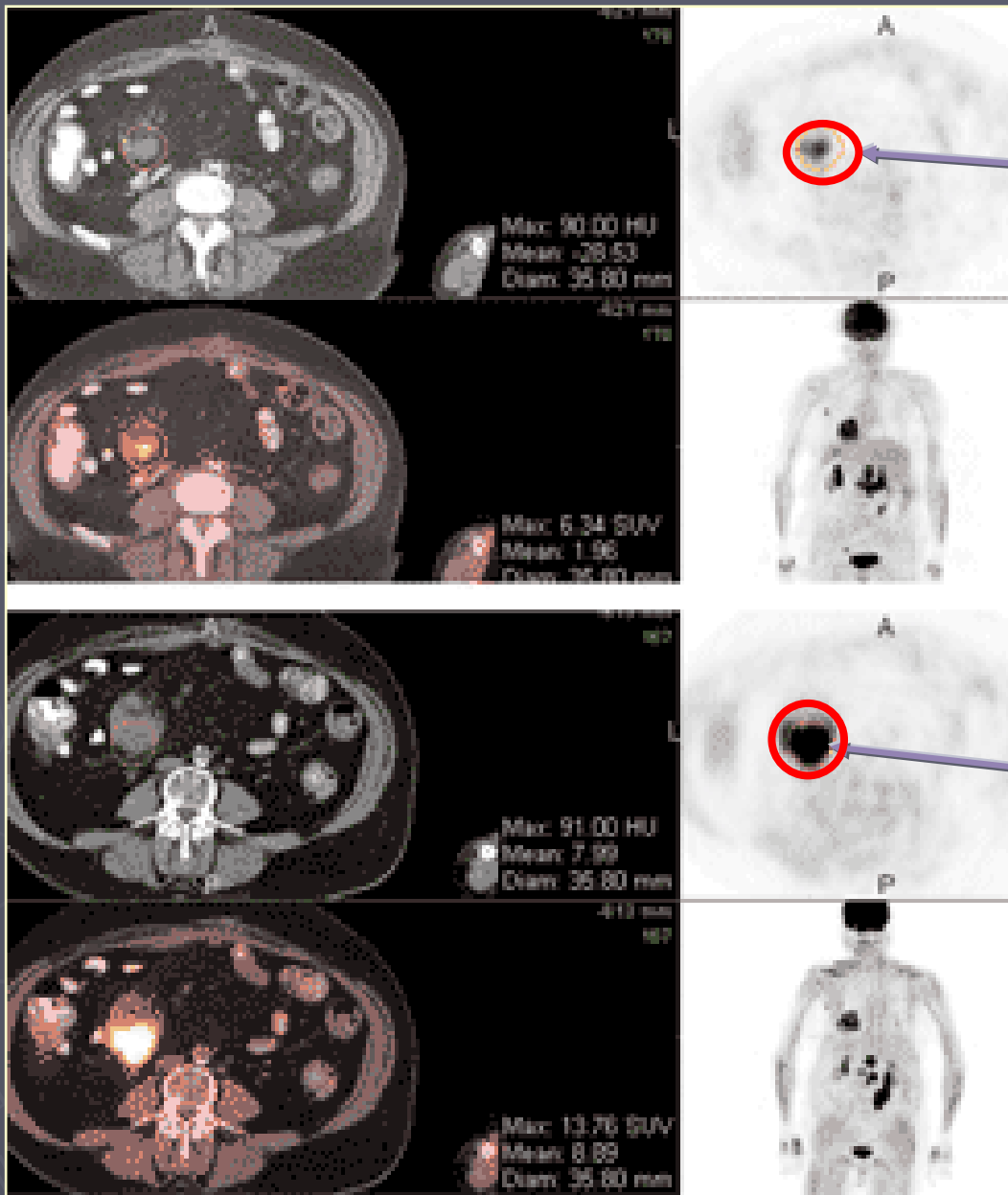
Sept 2000

Complete remission after taxotere &
LHRH antagonists



Dec 2000

Persistent complete
remission



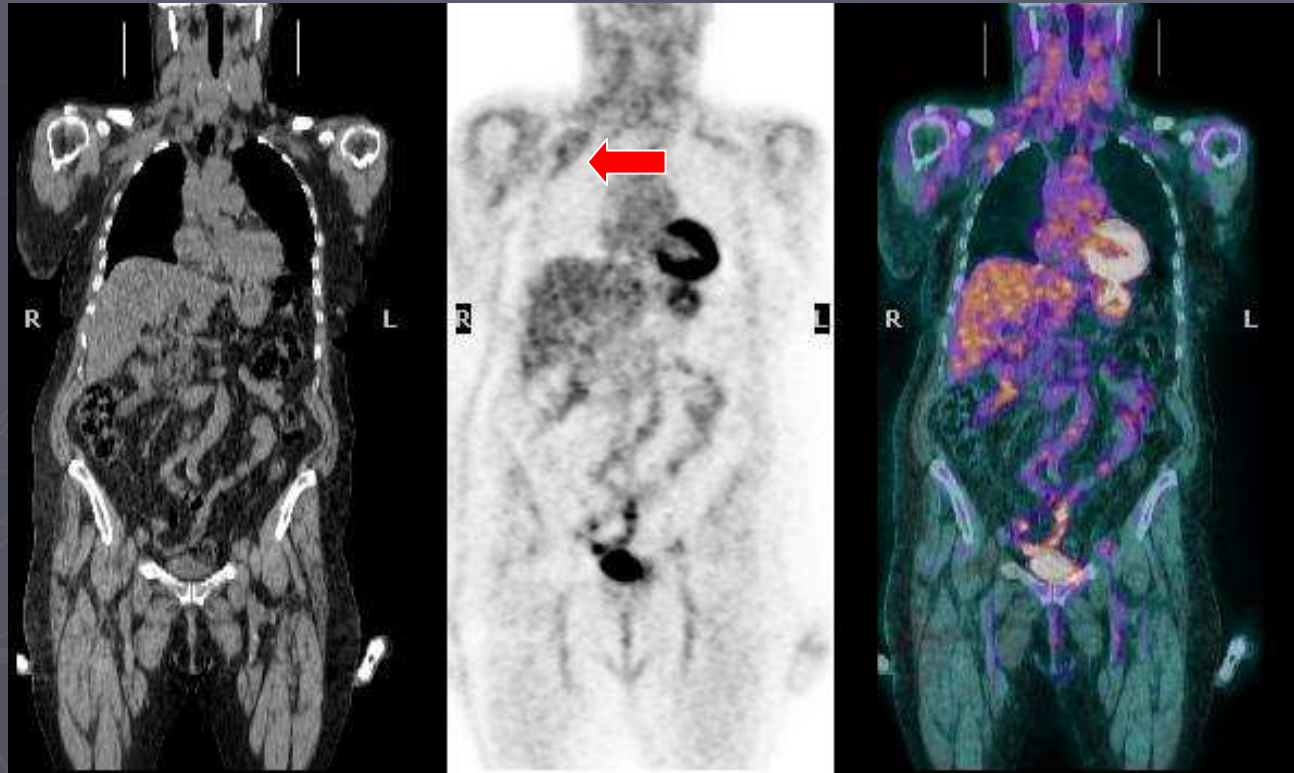
Before therapy
SUV max = 3.5

During therapy
SUV max = 10

No response to therapy: bad prognosis

PET and Radiotherapy

FDG-PET makes differential diagnosis (DD)
between the RADIATION induced damage and
recurrence disease



DD between actinic reaction and recurrence or relapse disease

It is important to perform PET about *2-3 months* after radiotherapy conclusion to esclude post-actinic reaction

Diagnosi e stadiazione di sospetta recidiva locale e a distanza

Incerto: FDG/PET esame di primo livello in caso di sospetta recidiva a distanza, soprattutto quando l'imaging convenzionale è equivoco o dubbio.

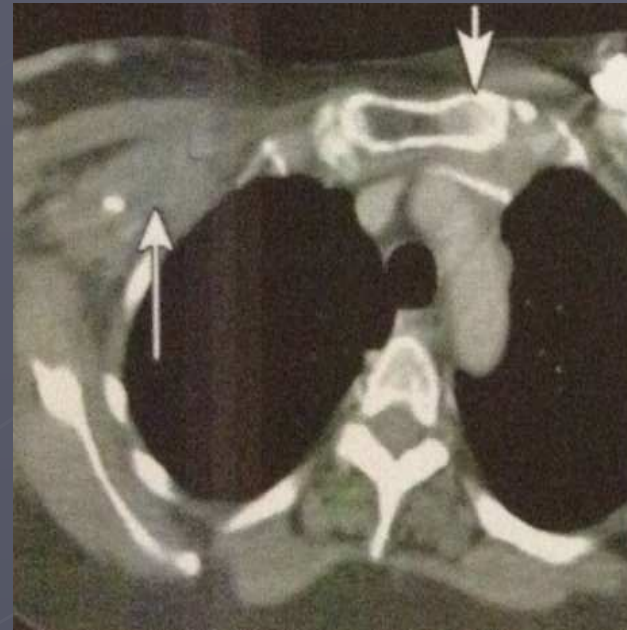
In caso di ripresa clinica, radiologica o biumorale (Ca.15-3, CEA) la PET/CT sembra meglio performante dell'imaging convenzionale:

- 1) PET > CT e Bone Scan nella ripresa a distanza (gabbia toracica)**
- 2) PET > US e MMx nella ripresa locale**
- 3) PET > RM nello studio dei linfonodi (regione ascellare ed extraascellare)**

La PET e RM sono più sensibili della US e CT nella individuazione della ripresa di malattia mammaria.

La PET può individuare lesioni non apprezzabili con indagini radiologiche convenzionali fino al 45% dei casi.

Ripresa linfonodale e ossea



50 anni con storia di ca. mammario dx, alla PET/CT captazione ascellare dx e captazione sternale (= metastasi osteoblastica alla TC).

Ripresa linfonodale



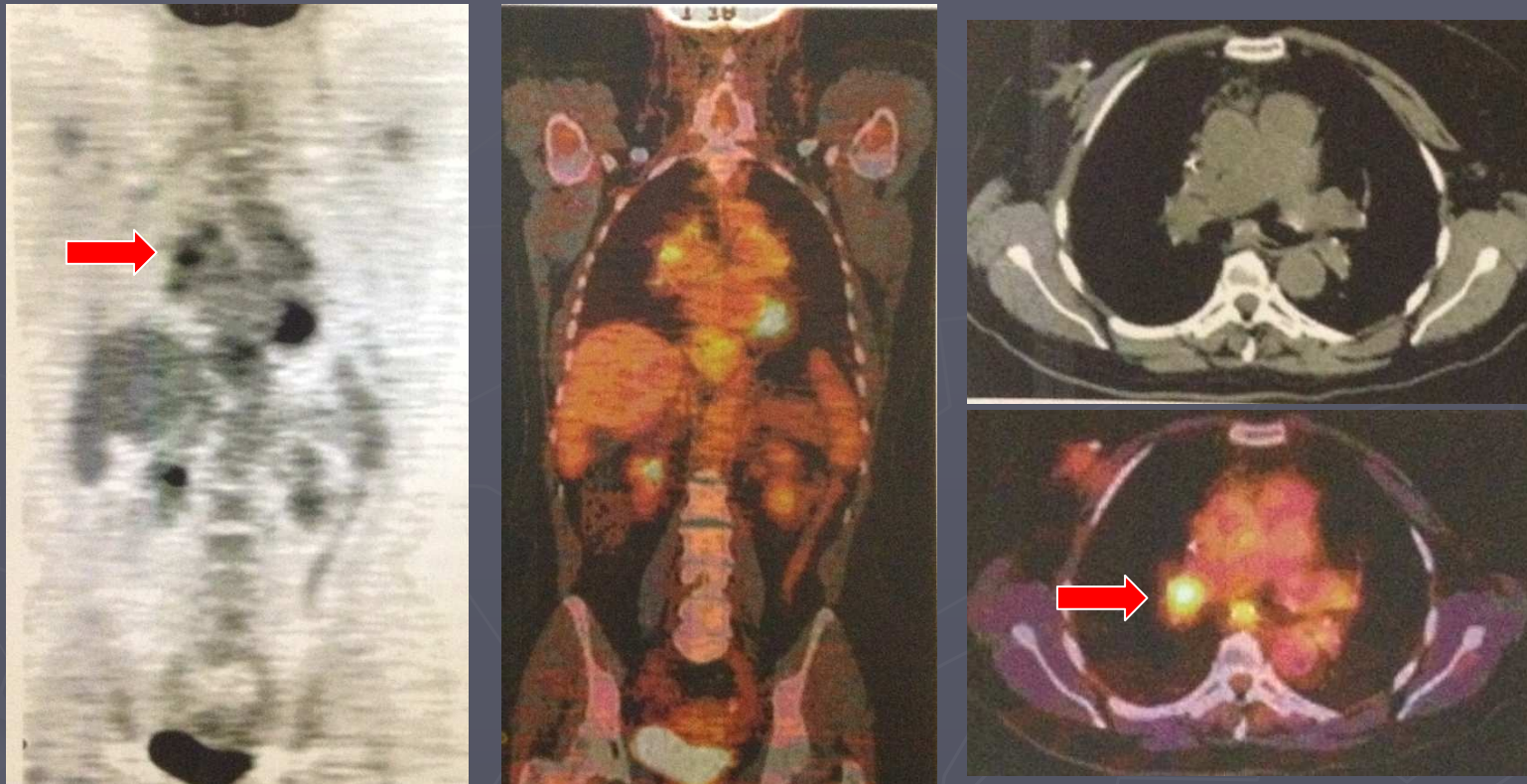
38 anni, mastectomizzata e sottoposta a CHT adiuvante, radioterapia e ricostruzione mammaria per ca mammario dx, Markers tumorali normali.

1) TC dubbia per adenopatia sopraclavicolare e giugulare inferiore (<10mm)

2) Immagini di fusione PET/CT evidenziano un incremento dell'uptake dell'FDG nelle sedi descritte alla TC.

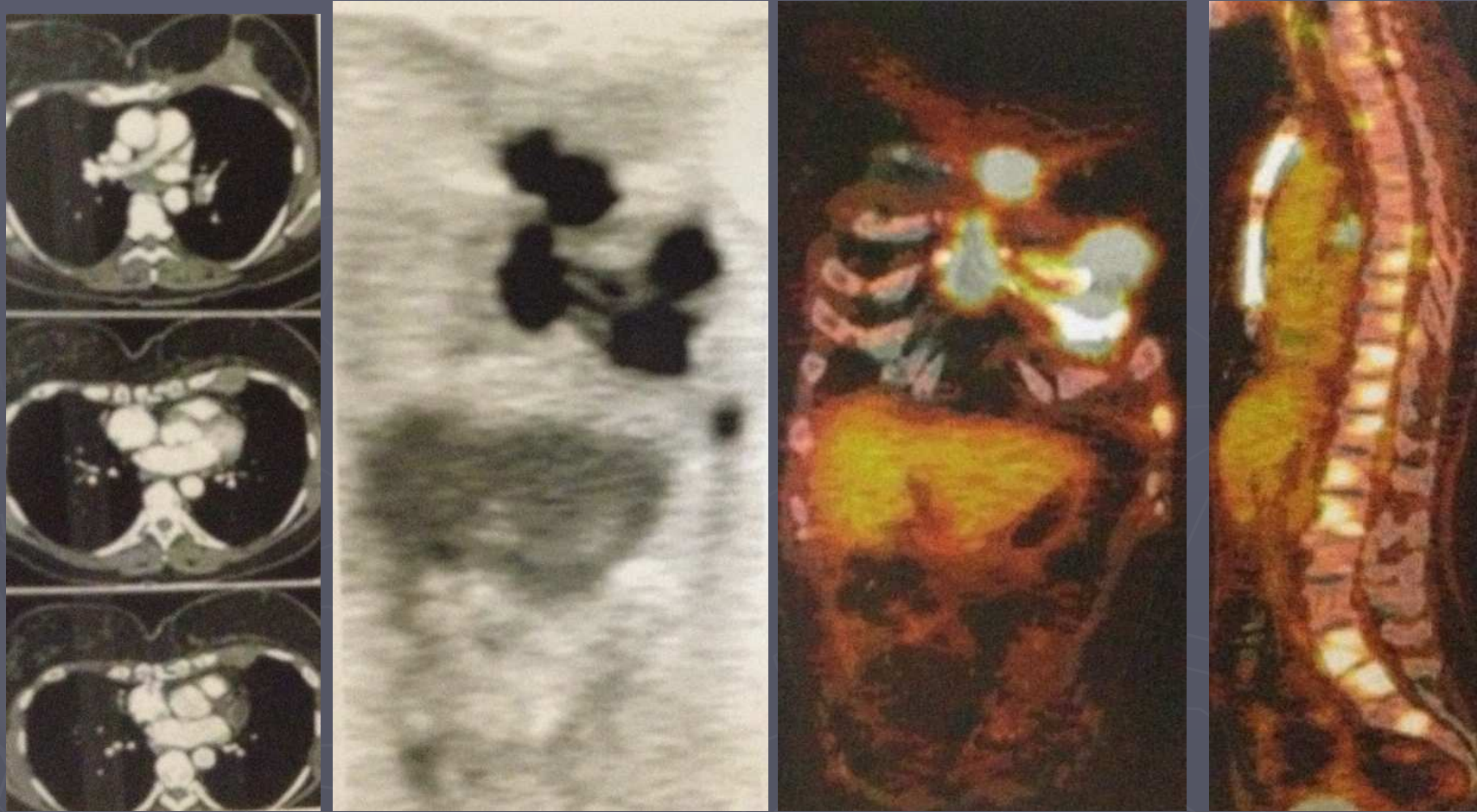
3) Pronta risposta alla CHT = linfonodi non visualizzabili alla PET/CT.

Ripresa linfonodale



PET/CT in paziente con sospetta ripresa di malattia: metastasi ilare polmonare dx.

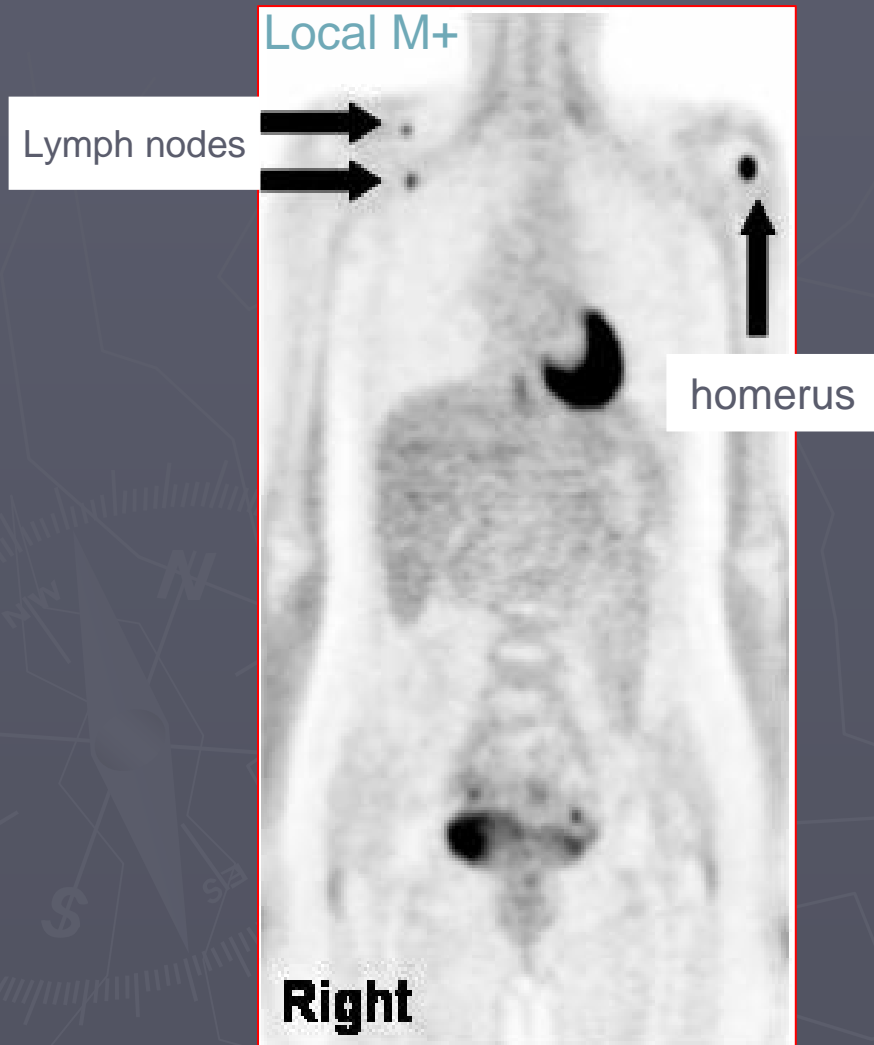
Ripresa mammaria, ossea e linfonodale



Sospetto di ripresa di malattia mammaria: esteso ripresa di malattia locale con interessamento della mammella, sterno, parete toracica anteriore, linfonodale ilare e massiva ossea (rachide)

Ripresa linfonodale ossea ed epatica

Singolo "Whole Body Scan" (15' di acquisizione)



Increase of tumor marker with negative conventional imaging

Tumour marker - guided PET

45 PATIENTS* WITH ELEVATED CA15.3 AND/OR CEA
AND NORMAL CONVENTIONAL IMAGING

	PET
Sensitivity (%)	92 (24/26)
Specificity (%)	75 (9/12)
Pos pred value (%)	89 (24/27)
Neg pred value (%)	82 (9/11)
Accuracy (%)	87 (33/38)

Combined
PET/CT

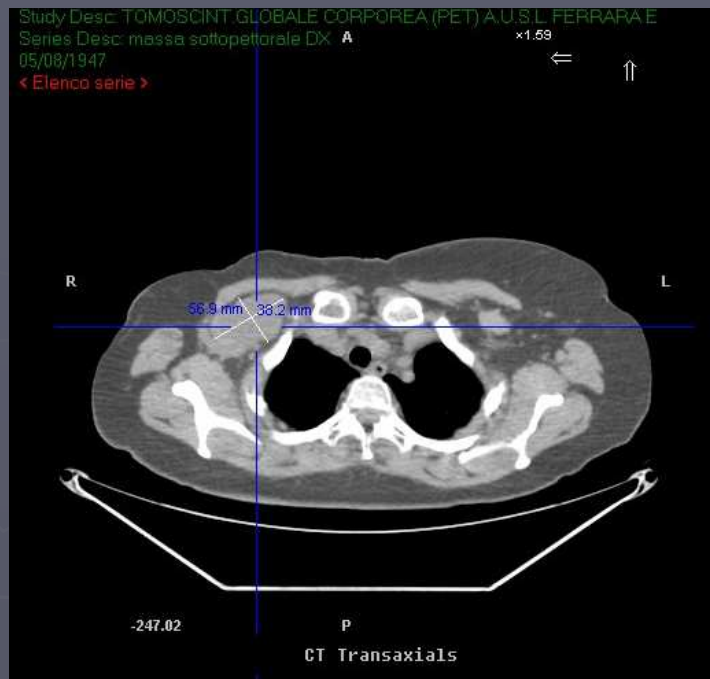
92%

94%

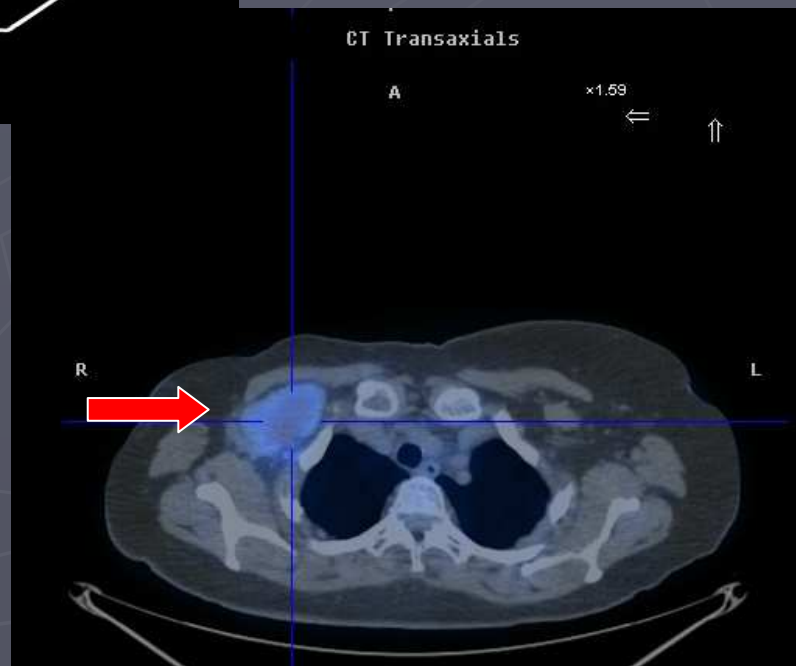
* In 3 patients PET detected unknown second primaries

Tumour marker-guided PET (suspected biochemical diagnosis)

↑ Ca 15.3



Neof. sottopettorale
destra (53 x 33 mm)
SUV max 4.8



US e RM mammarie negative

Follow up - increased marker

FDG-PET images bone/soft tissue involvement with a single examination

↑ Ca 15.3



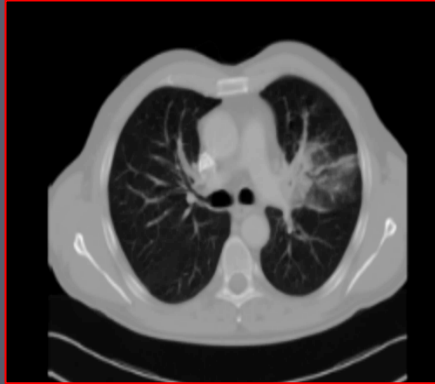
lung



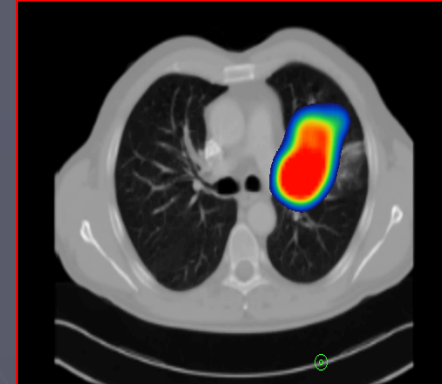
liver



Bone (humerus, vertebrae)



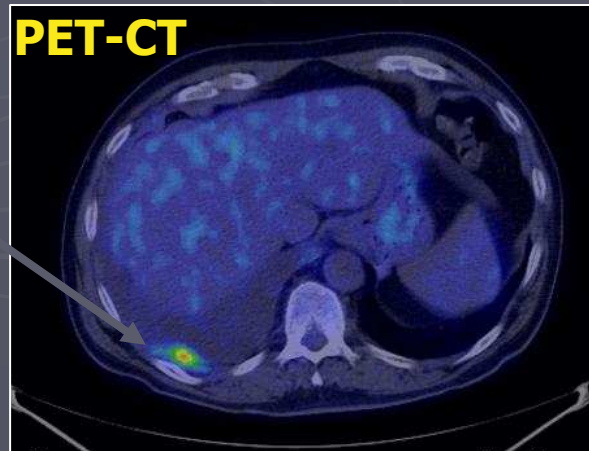
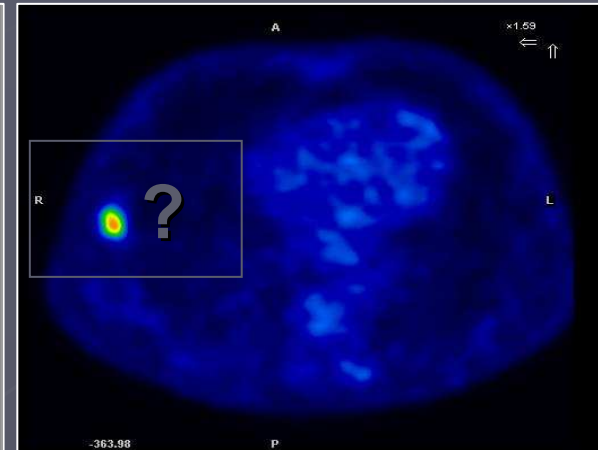
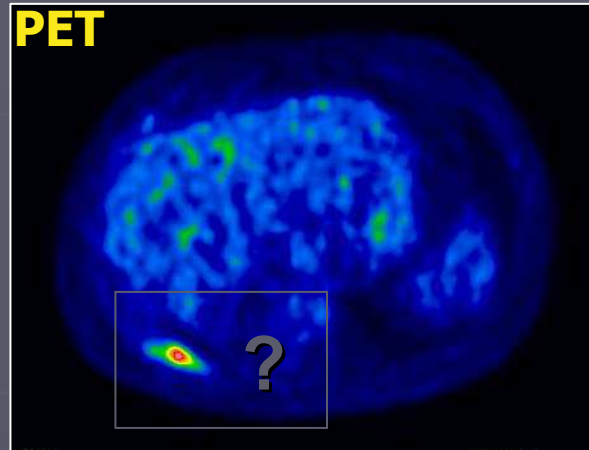
Why to fuse PET with CT?



- ❖ To combine anatomical and functional (metabolic) informations;
- ❖ To have anatomical references (by CT) during PET study;
- ❖ To improve lesion localization by CT guidance;
- ❖ To plan biopsy, surgery and radiation therapy;
- ❖ To have faster attenuation correction compared to radionuclide source

FDG-PET/CT improves lesion localization

FDG-PET stand alone is not able to detect correctly the lesion site

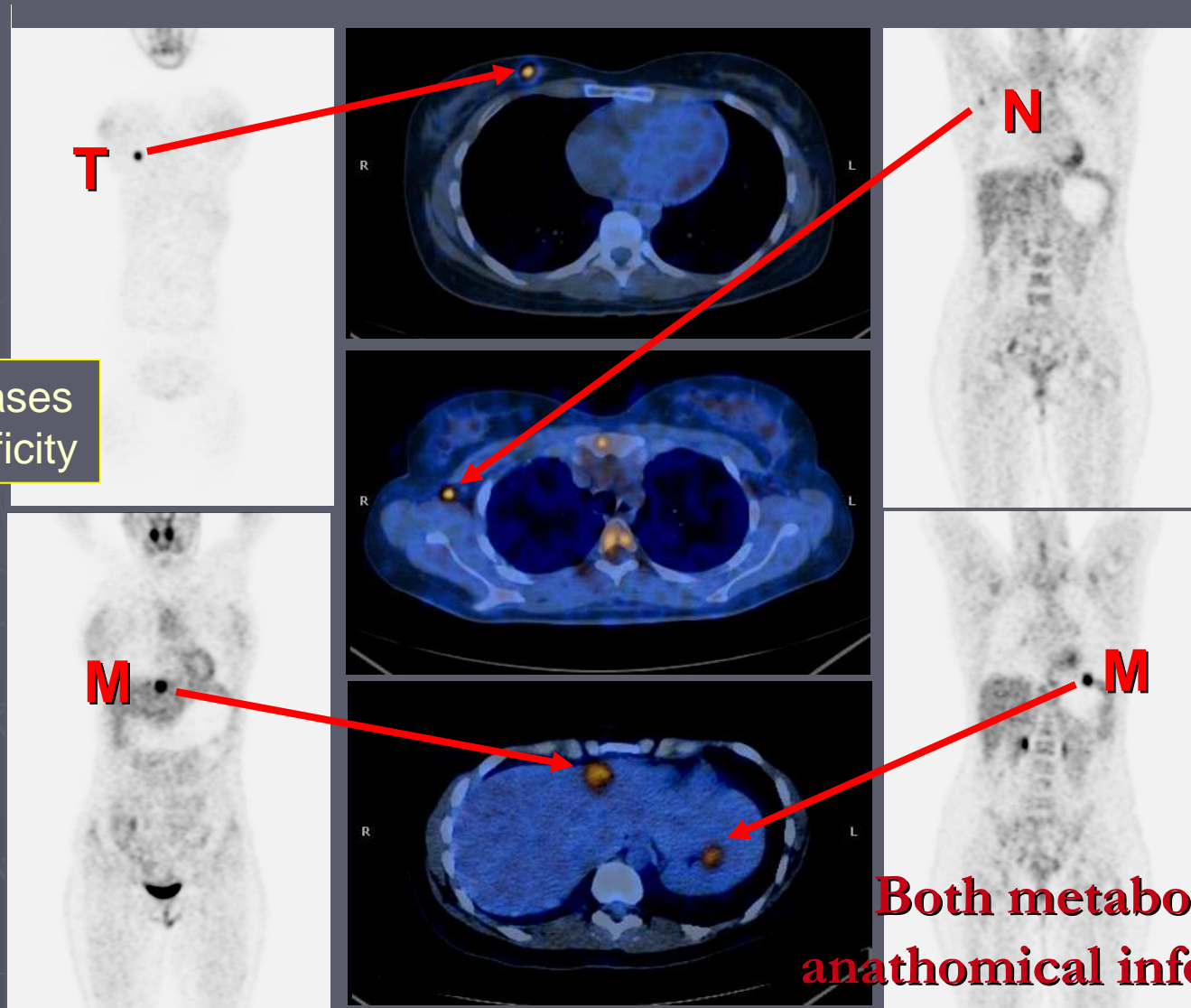


lung

CT increases the specificity of PET

rib

FDG-PET/CT for a whole body staging



Conclusioni

- 1) FDG PET/CT utile nel re staging in pazienti con documentata ripresa di malattia o nei casi di sospetta ripresa.
- 2) FDG PET/CT utile nello staging del tumore localmente avanzato e "inflammatory breast cancer".
- 3) FDG PET/CT utile nella identificazione di linfonodi extra-ascellari e di metastasi a distanza.
- 4) Fornisce informazioni nello stadio clinico IIB e in stadio IIIA operabile.
- 5) Limite della risoluzione spaziale (5-6 mm) che non consente di individuare precocemente N+ e micrometastasi.
- 6) PET/CT non sostituisce la stadiazione linfonodale locoregionale affidata alla tecnica del LNS.
- 7) La PET non è indicata nello "stage I" del tumore mammario.
- 8) Le informazioni metaboliche della PET sono utili per la valutazione della risposta precoce alla CHT.
- 9) Valore prognostico.

... **per approfondire** ...

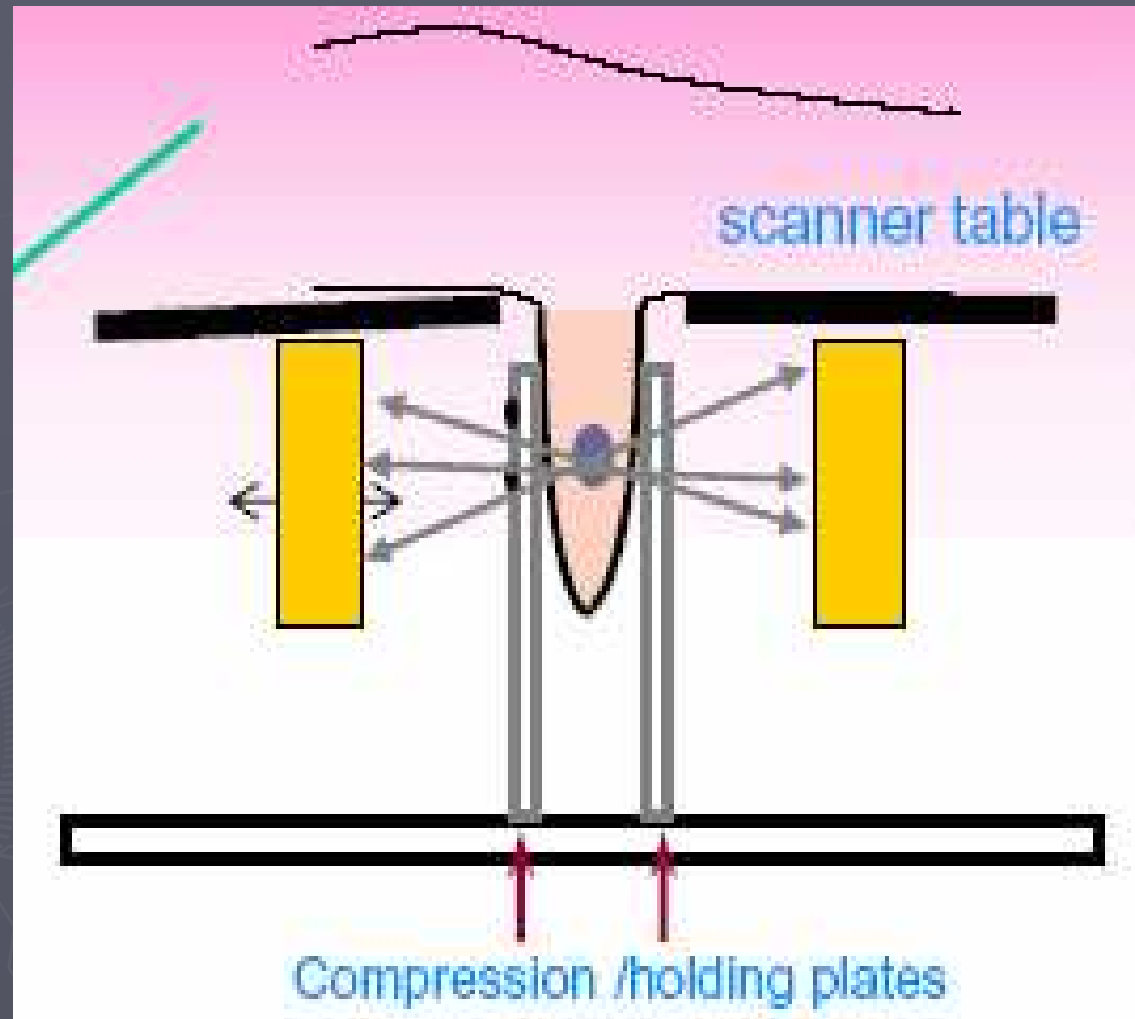
Performance of FDG PET/CT in the Clinical Management of Breast Cancer

Groheux et al. Radiology volume 266: n°2 February 2013

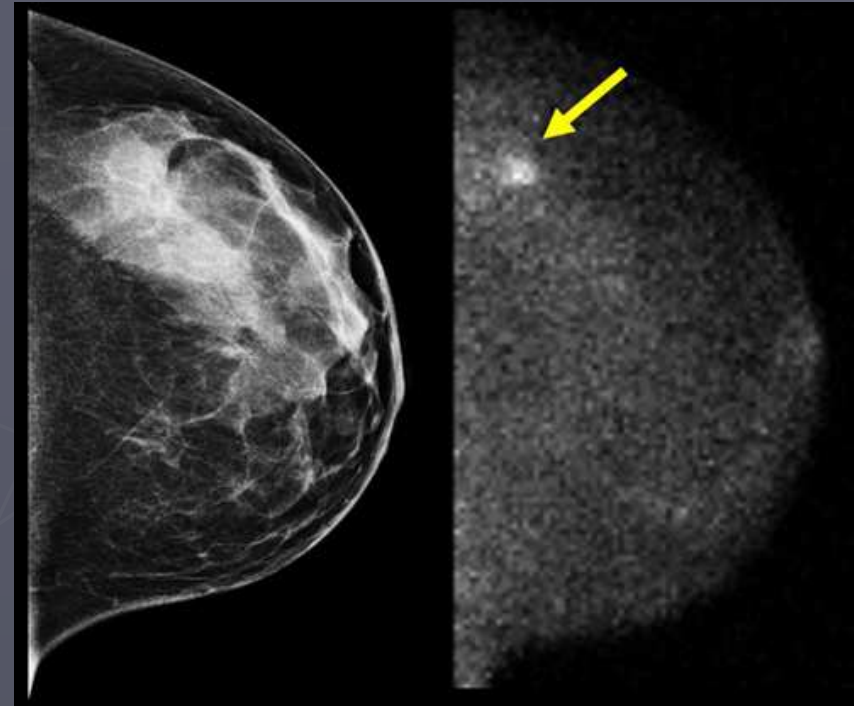
Criteria for appropriate use of FDG-PET in Breast Cancer - ORientamenti 3

ASSR dossier Regione Emilia Romagna 207/2011

Positron Emission Mammography



Positron Emission Mammography



- PEM improves breast cancer detection;
- PEM improves ability to differentiate between benign and cancerous lesions;
- Axillary lymph nodes staging;
- Functional tumor information (> tracer uptake => aggressiveness)

SNM Annual Meeting, San Antonio (Texas), June 2011

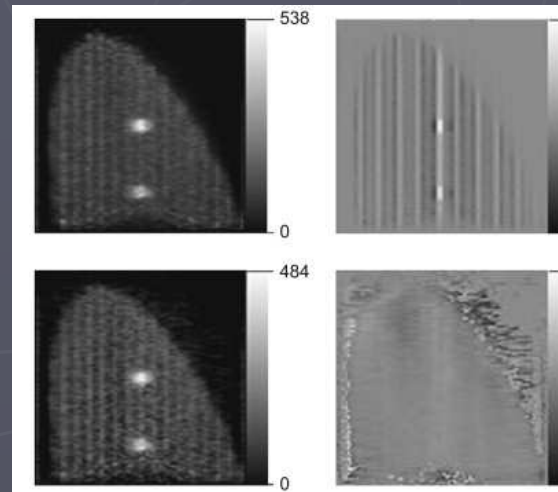
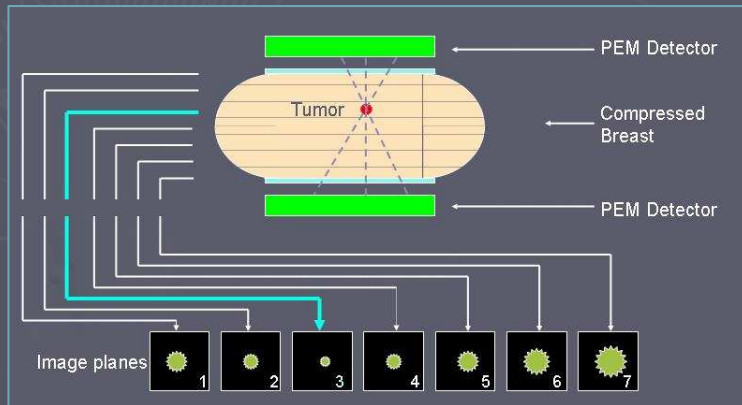
Positron Emission Mammography

^{18}F -FDG as radiotracer

2 detector heads mounted in compression paddles

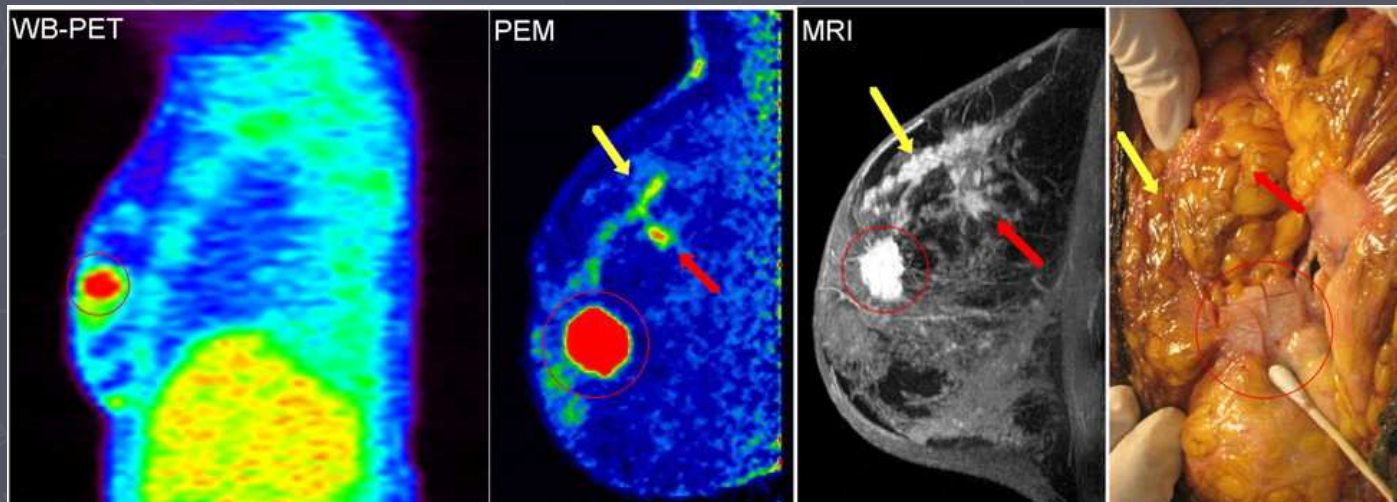
Intrinsic resolution **1.5mm**

CC & MLO mammographic projections: **10'** image acquisition



Positron Emission Mammography

PEM and MRI had comparably high sensitivity
PEM demonstrated 6% greater specificity than MR, reducing false positives
PEM was found to have 26% higher PPV than MR, potentially reducing unnecessary biopsies



RSNA Chicago, 2010

Positron Emission Mammography



Targeting PEM

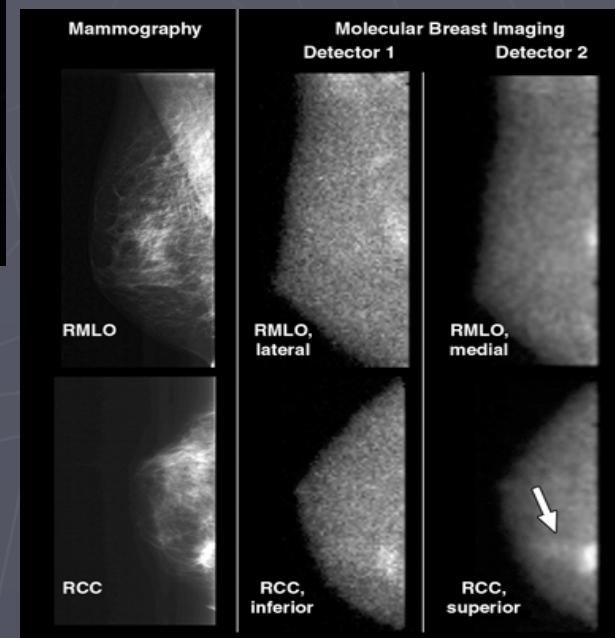
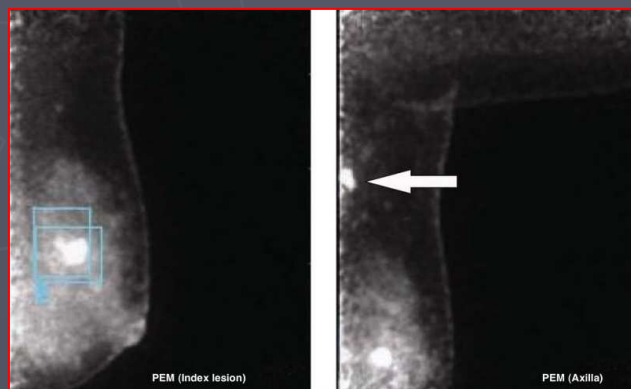
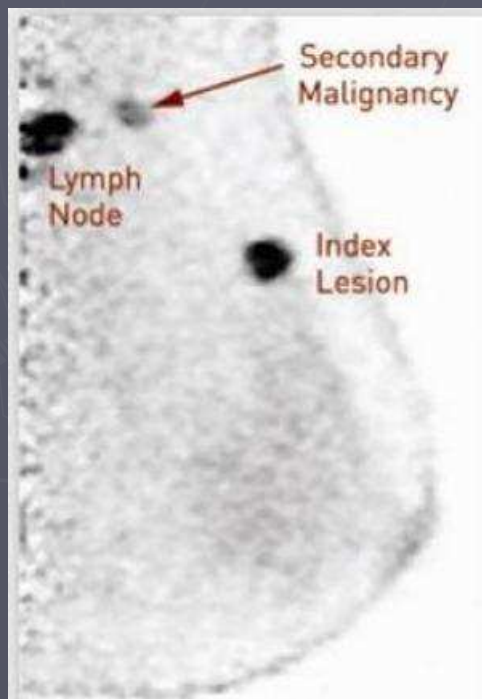
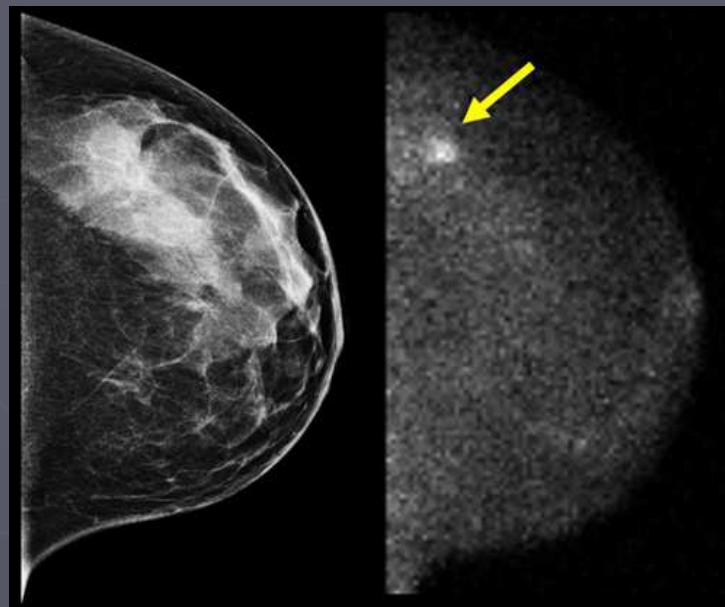


Sampling PEM

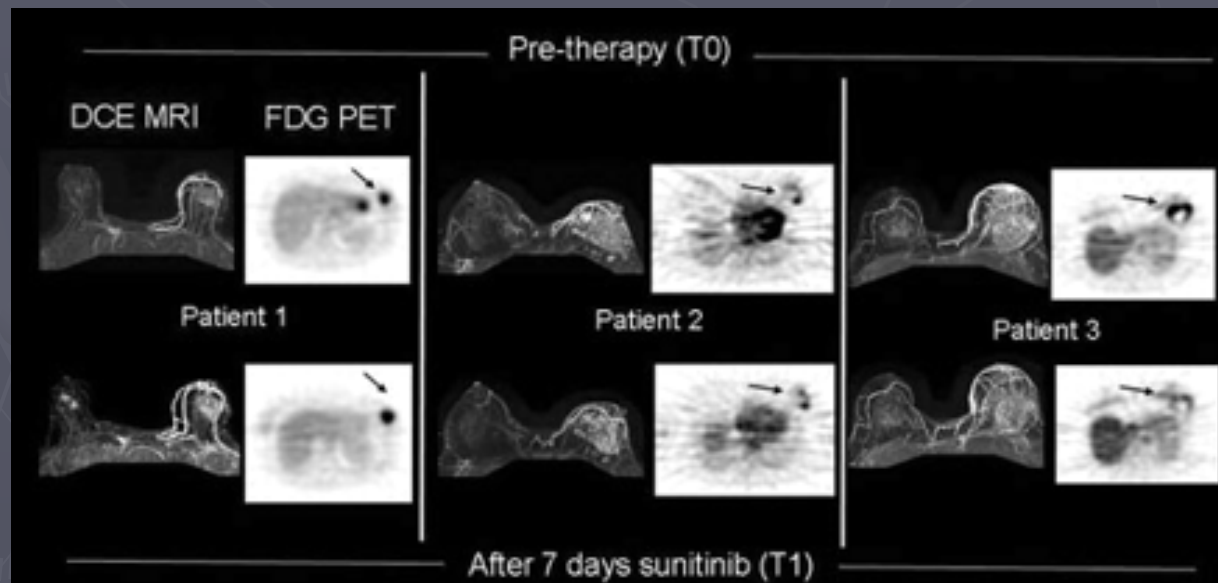
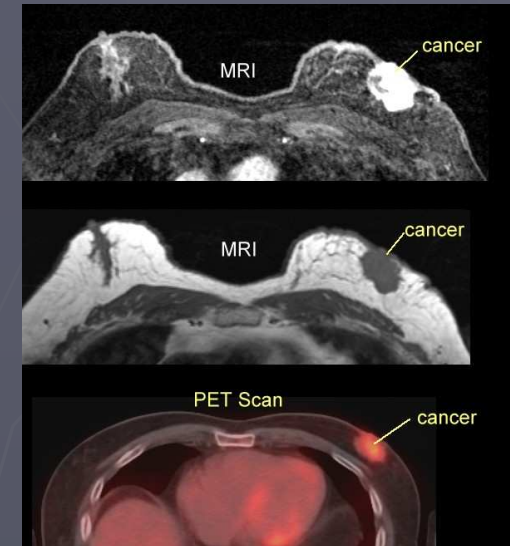


**PEM Biopsy with
VAB (Mammotome)**

Positron Emission Mammography



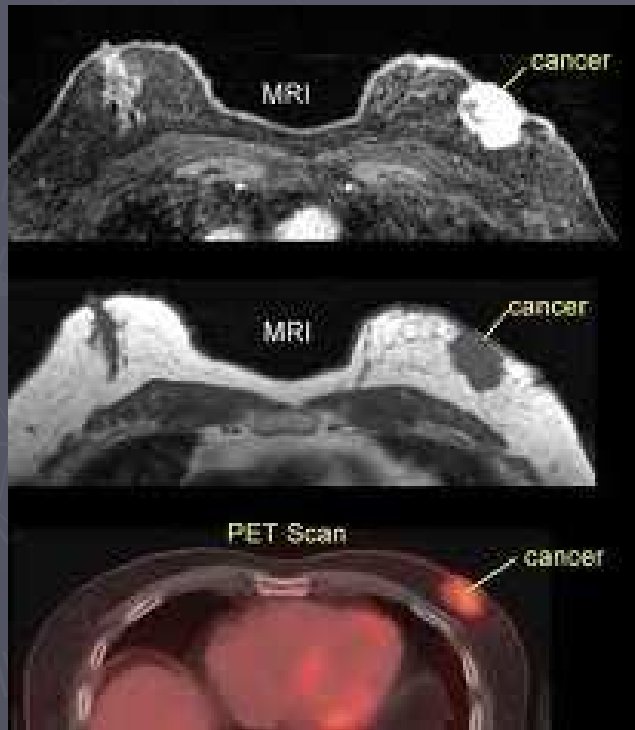
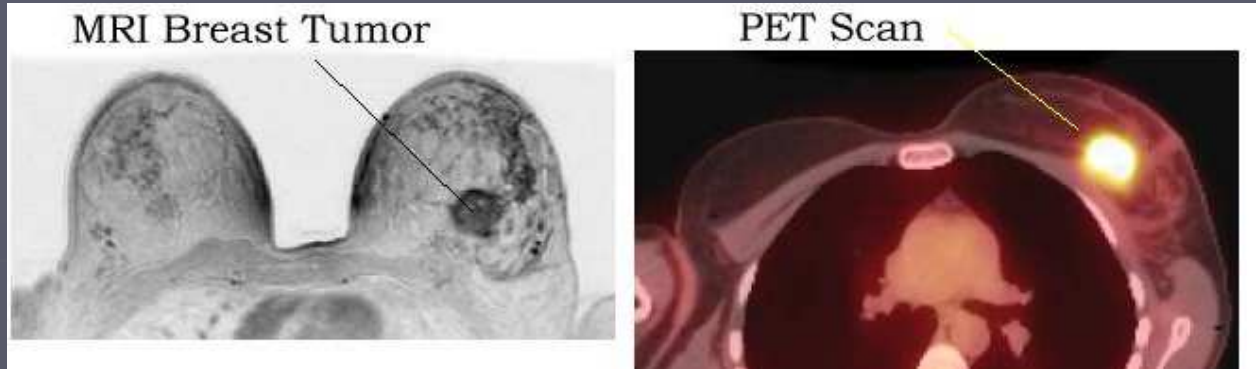
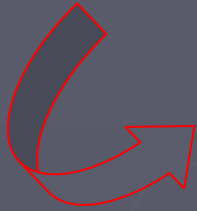
“Last generation tomograph”: PET-PEM/MRI



Specht et al. Cancer Research 2009

Combined PEM/MRI: a new dimension in Breast Imaging

FUTURE



PEM and MRI scanning together saw additional breast lesions producing a 20% absolute increase in "sensitivity" when compared to using MRI alone.



Grazie per l'attenzione