5th International Workshop on PET in Lymphoma

Metabolic Tumour Volume (MTV) & Total Lesion Glycolysis (TLG)

Menton (France), Palais de l'Europe,
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Methodological Aspects

Annibale Versari
Nuclear Medicine
Az. Osp. S.Maria Nuova - IRCCS
Reggio Emilia
Italy

ARCISPEDALE SANTA MARIA NUOVA
AZIENDA OSPEDALIERA REGGIO EMILIA
Regione Emilia-Romagna

SERVIZIO SANITARIO REGIONALE
EMILIA-ROMAGNA
Azienda Ospedaliera di Reggio Emilia
Arcispedale S. Maria Nuova
Istituto in tecnologie avanzate e modelli assistenziali in oncologia
Istituto di Ricovero e Cura a Carattere Scientifico

versari.annibale@asmn.re.it

Literature data

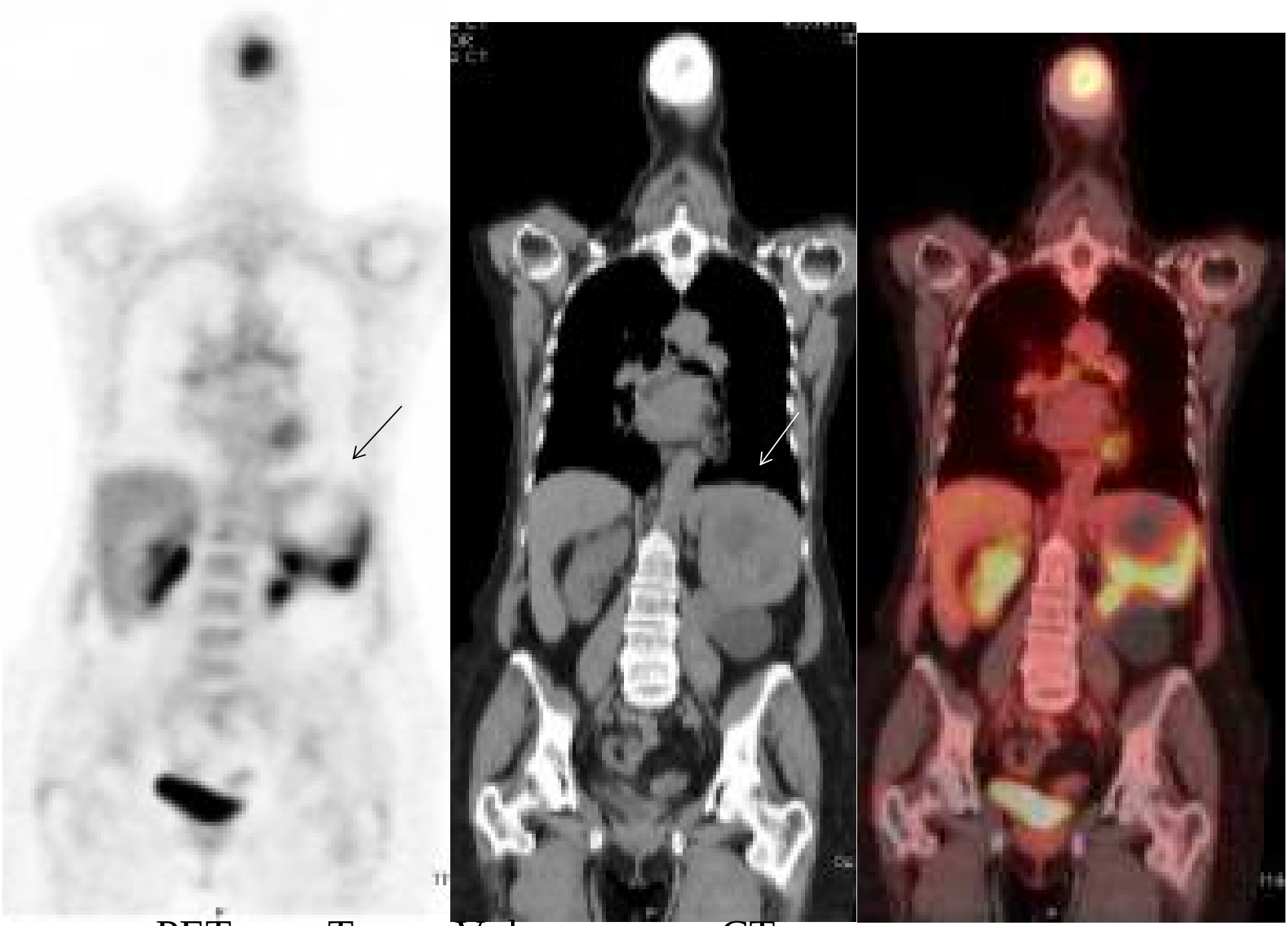
The Tumor Burden is an important prognostic tool in Lymphoma …

Volume CT

Morphologic information

Contour definition

…but the definition on CT images is complex and time consuming



PET Tumor Volume CT

FDG PET

- Metabolic information (SUV)

but

- The metabolic tumor volume definition needs some rules

BTV definition: which method?

Several strategies in using PET for target volume definition in radiotherapy treatment planning are being investigated:

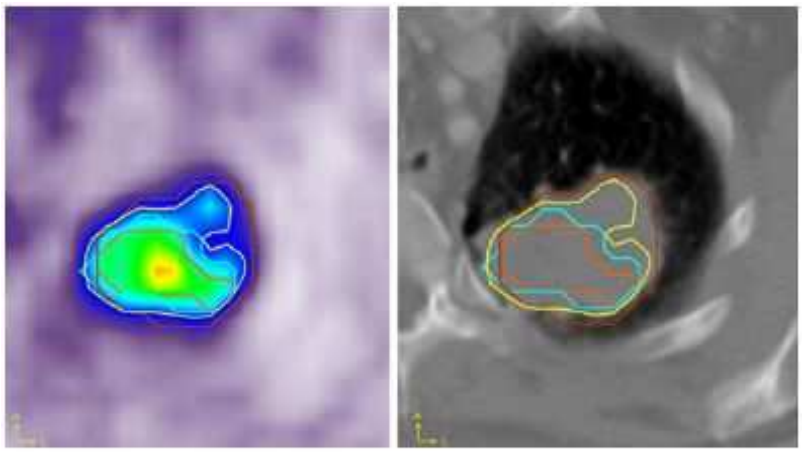
- **visual contouring**
- **Fixed or relative threshold** (SUV=2.5, 30-40-50 % of peak activity…)
- **adaptive threshold** (dependence on Signal/Bkg ratio and lesion size, dependence on reconstruction algorithm…)
- **gradient based** (adaptive region growing)
- **statistical techniques** (fuzzy locally adaptive bayesian, Markov models, k-means clustering…)

Reproducibility

Robustness

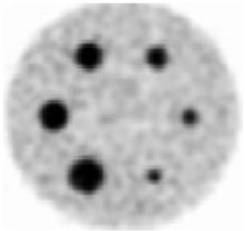
Accuracy

Automation



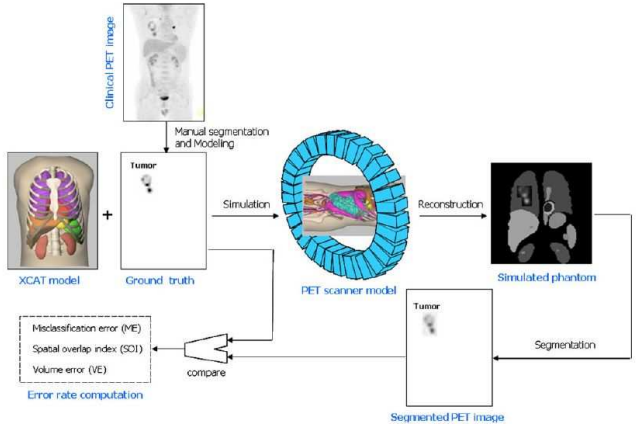
Zaidi H et al. Eur J Nucl Med Mol Imaging. 2010 Nov;37(11):2165-87

Validation = *"fidelity to the truth"*



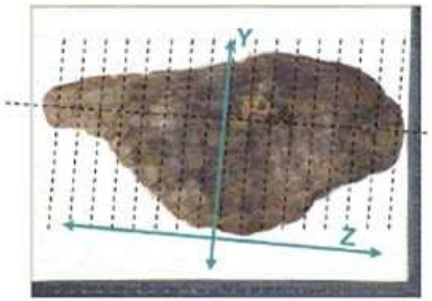
Spherical and homogeneous objects

Anthropomorphic phantoms



Simulated data

Ground truth



Histopathological data

<u>BUT</u> the histopathological data evaluation is particularly complex, given that:

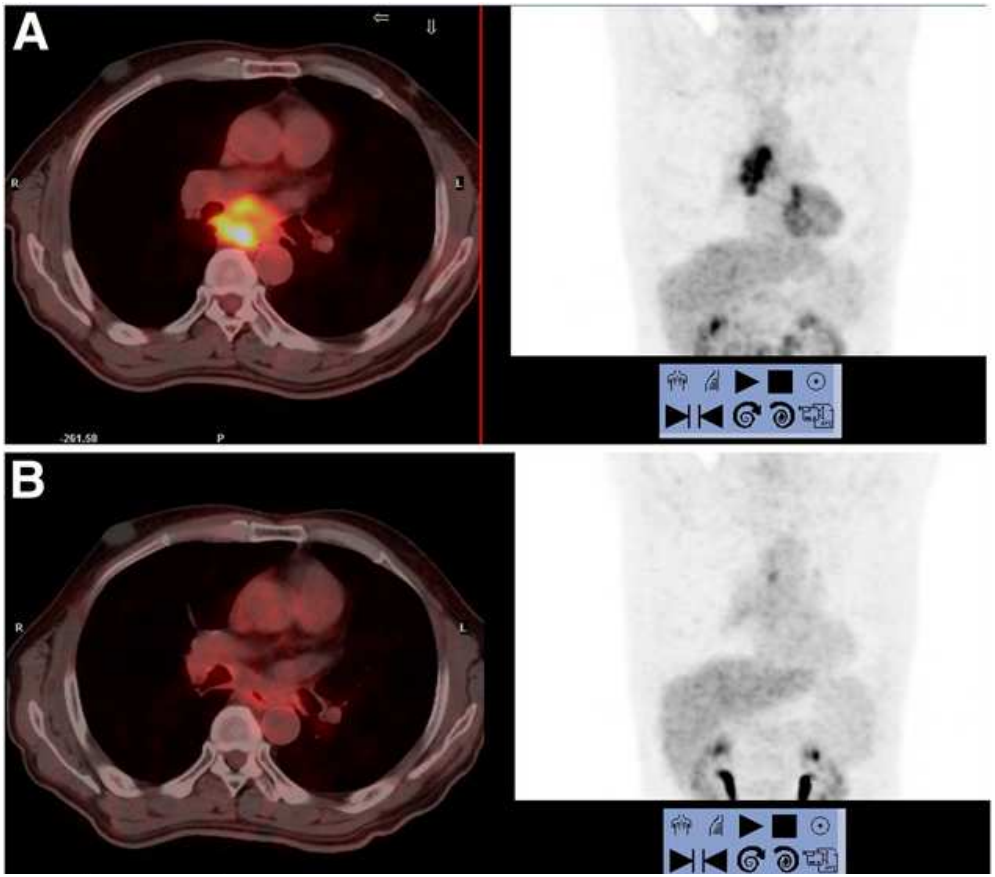
- PET study must be performed before surgical resection of the tumor
- the effects of sample shrinkage in the different conditions (in vivo and and in vitro) must be considered.

<u>The volumetric analysis of the the surgical specimen must be done through an accurately and reliably procedure</u>.

Journal of Nuclear Medicine, published on September 11, 2014 as doi:10.2967/jnumed.114.142919

Value of Metabolic Tumor Volume on Repeated ^{18}F-FDG PET/CT for Early Prediction of Survival in Locally Advanced Non–Small Cell Lung Cancer Treated with Concurrent Chemoradiotherapy

Wei Huang*[1], Min Fan*[1], Bo Liu[2], Zheng Fu[3], Tao Zhou[1], Zicheng Zhang[1], Heyi Gong[1], and Baosheng Li[1]



… and many other tumors

- Esophagus
- Head&neck
- Ovarii
- ……

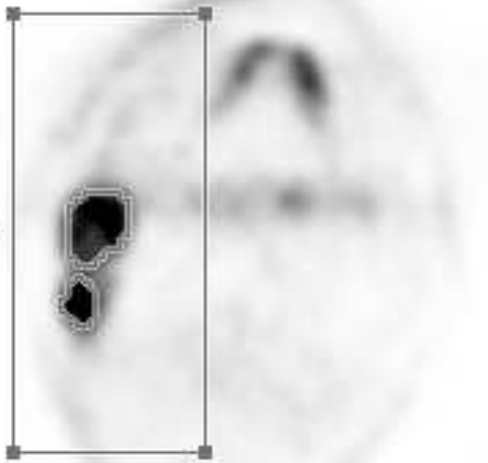
…. but Lymphoma has particular characteristics ….

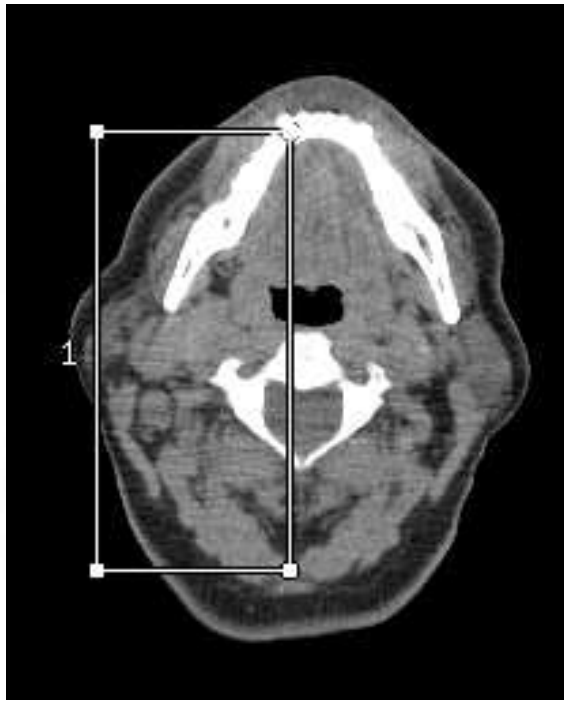
- Heterogeneous disease

Many different

- sites
- volumes
- uptakes (SUV)
- backgrounds

- Bulky – non-Bulky

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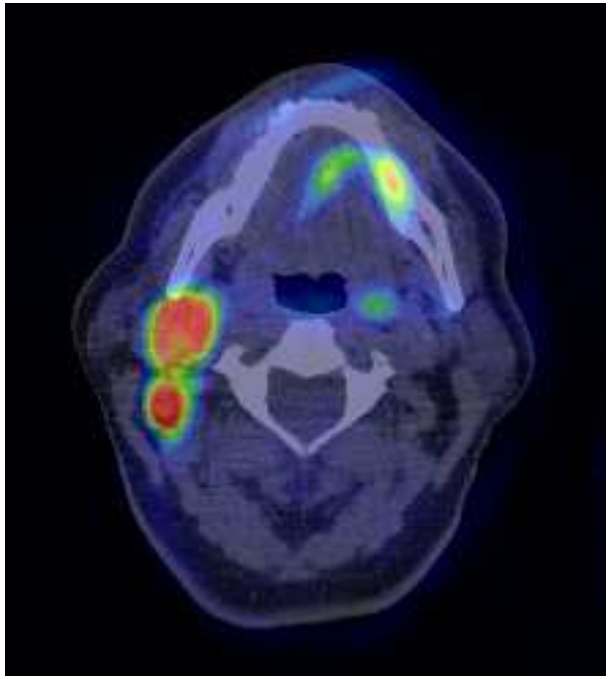
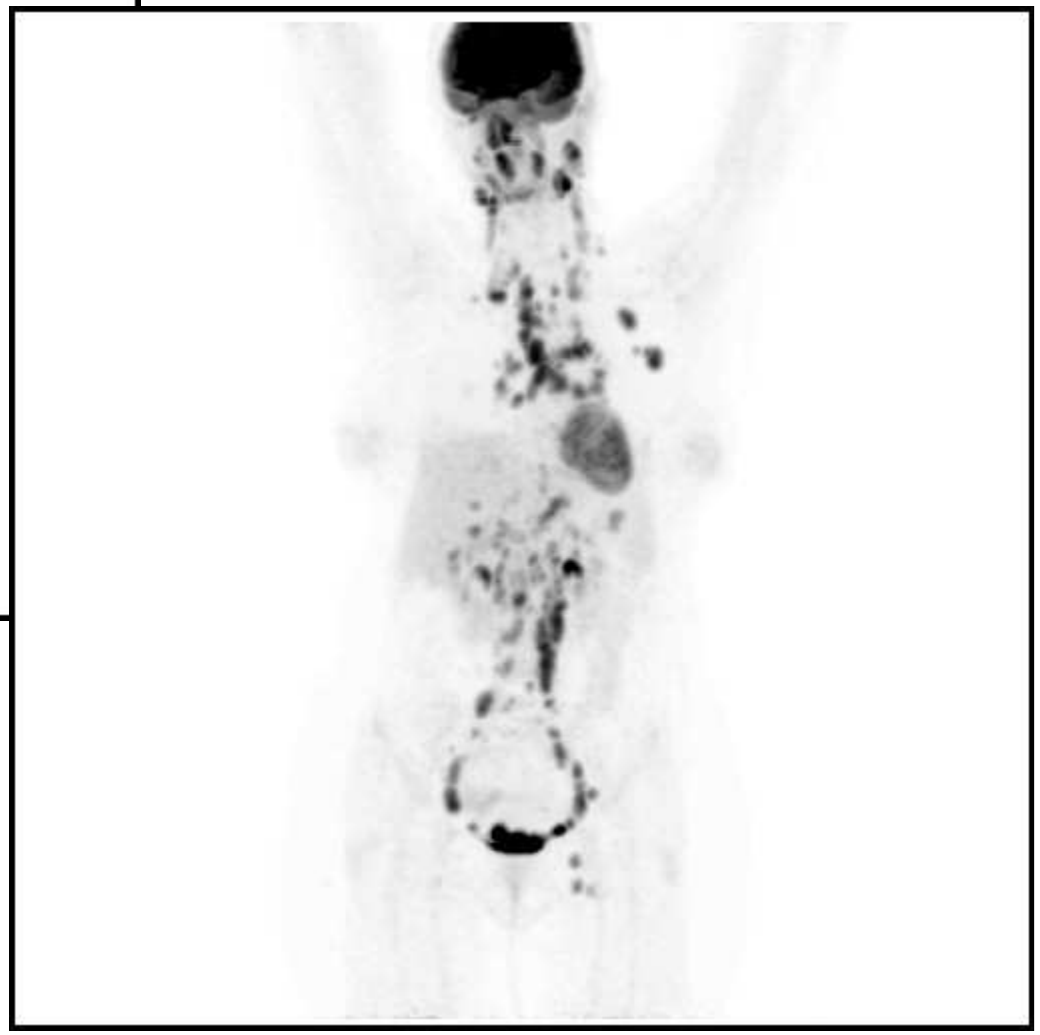


Hodgkin
Lymphoma

Non-Hodgkin
Lymphoma



Eur J Nucl Med Mol Imaging (2014) 41:1113–1122
DOI 10.1007/s00259-014-2705-y

ORIGINAL ARTICLE

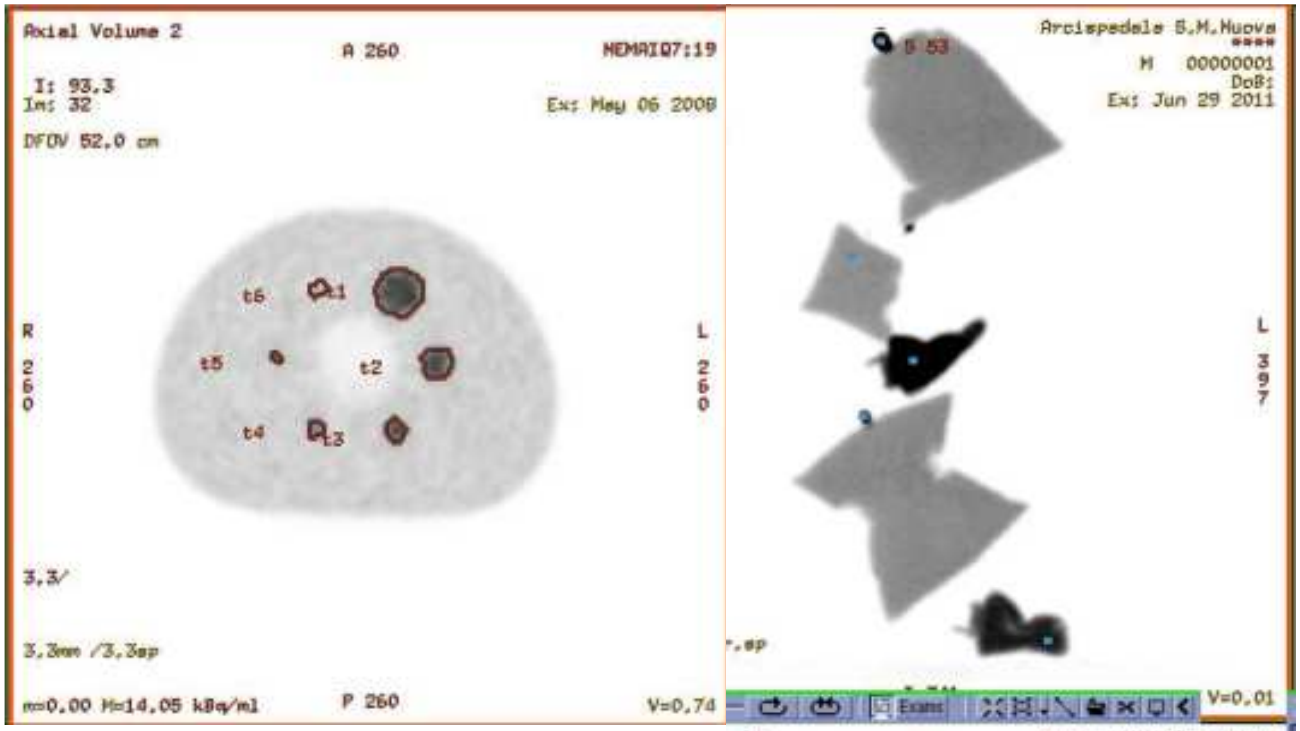
Metabolic tumour volumes measured at staging in lymphoma: methodological evaluation on phantom experiments and patients

Michel Meignan · Myriam Sasanelli · René Olivier Casasnovas · Stefano Luminari · Federica Fioroni · Chiara Coriani · Helene Masset · Emmanuel Itti · Paolo G. Gobbi · Francesco Merli · Annibale Versari

Comparison of 2 semiautomatic segmentation softwares in 2 centers

- **PET VCAR** - Volume Computer Assisted Reading – GE Healthcare
Nuclear Medicine Dept – Reggio Emilia (Italy)

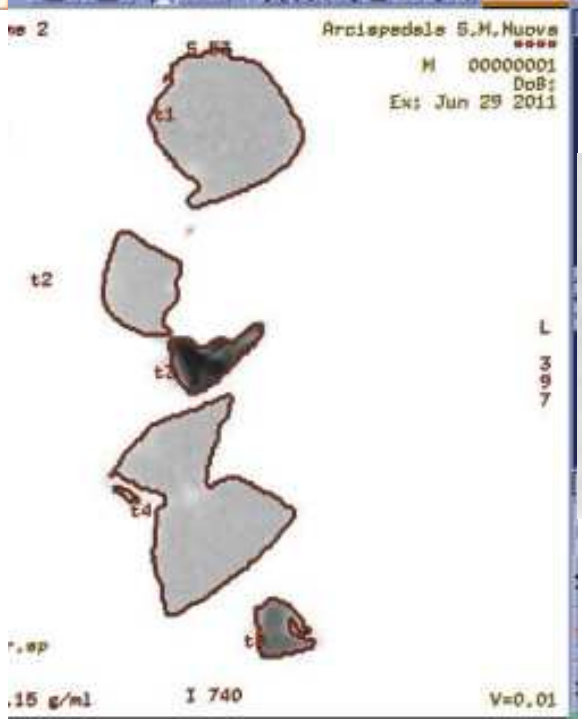
- **KEOSYS software**
Nuclear Medicine Dept – Créteil (France)

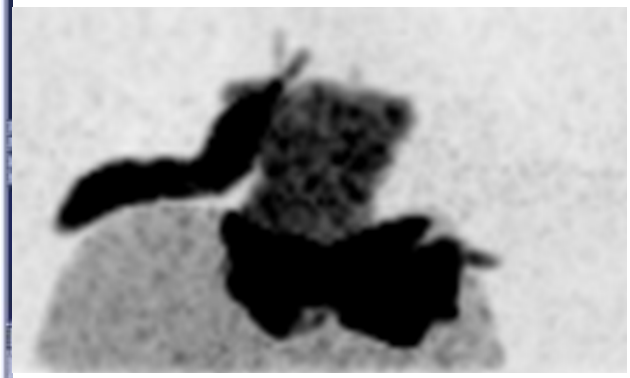


Nema phantom

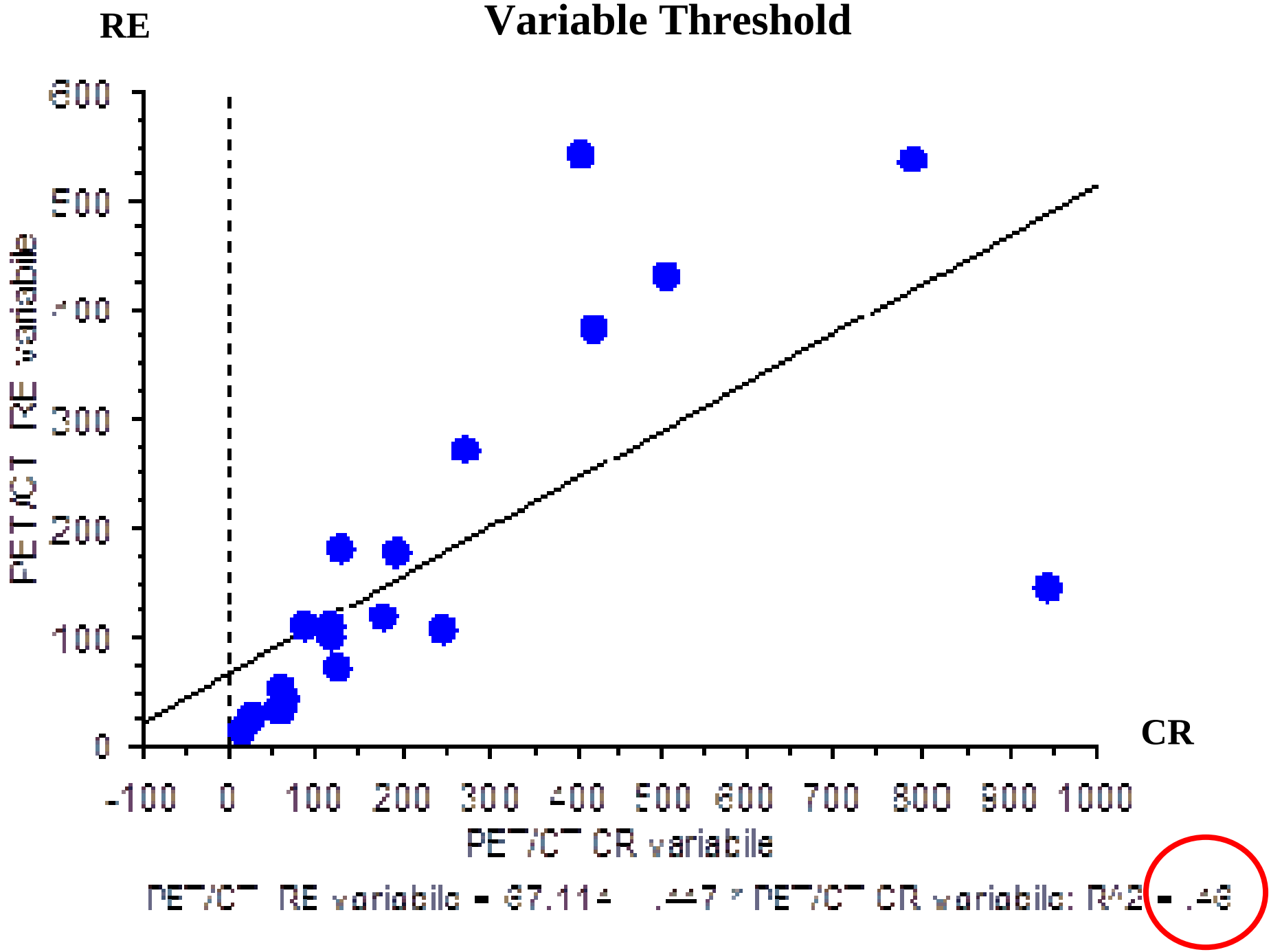
Anthropomorphic Phantom

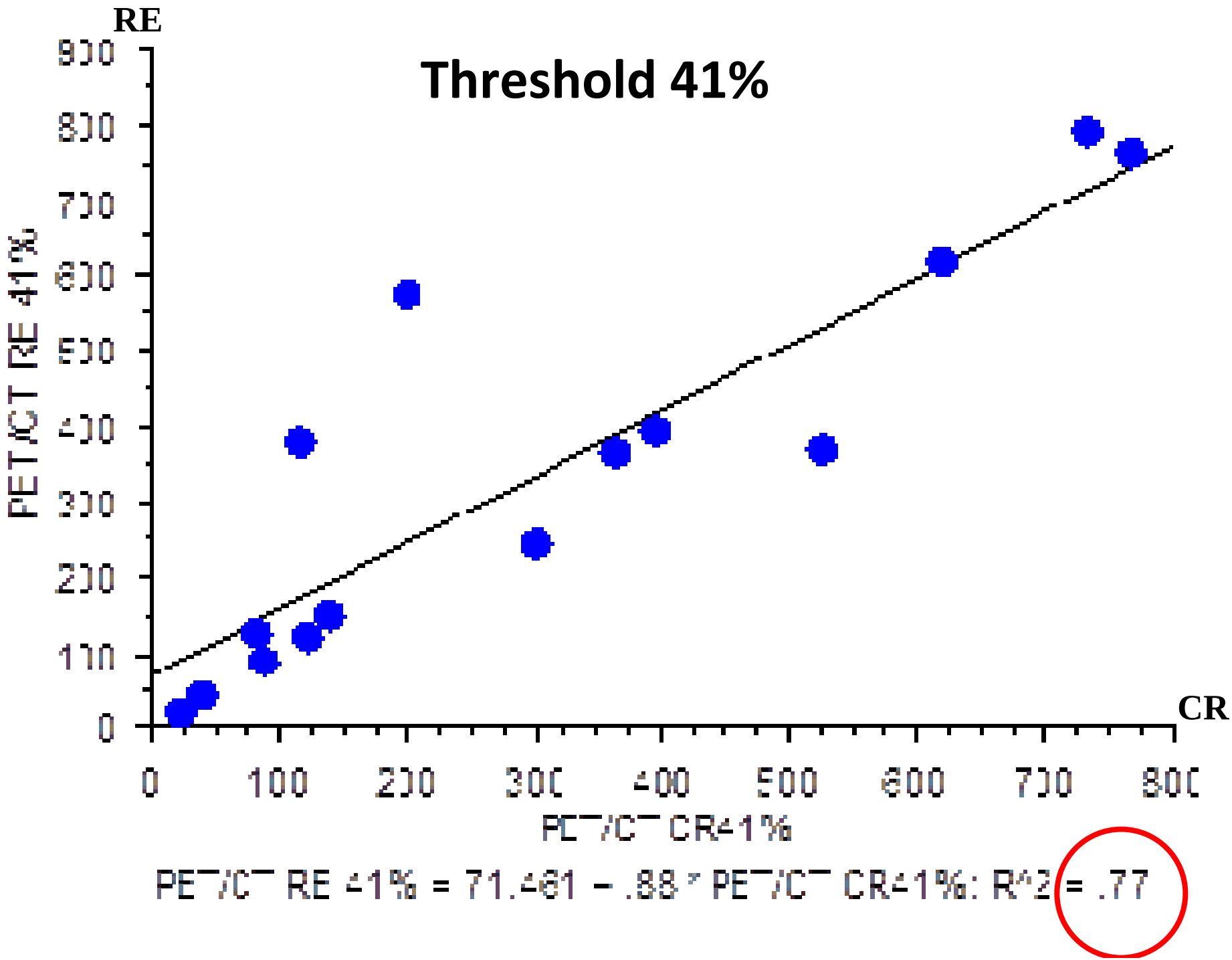
Irregular phantoms





Variable Threshold




RE
Threshold 41%
CR
0
100
200
300
400
500
600
700
800
PET/CT CR41%
PET/CT RE 41% = 71.461 – .88 * PET/CT CR41%; R^2 = .77

Eur J Nucl Med Mol Imaging (2010) 37:181–200
DOI 10.1007/s00259-009-1297-4

GUIDELINES

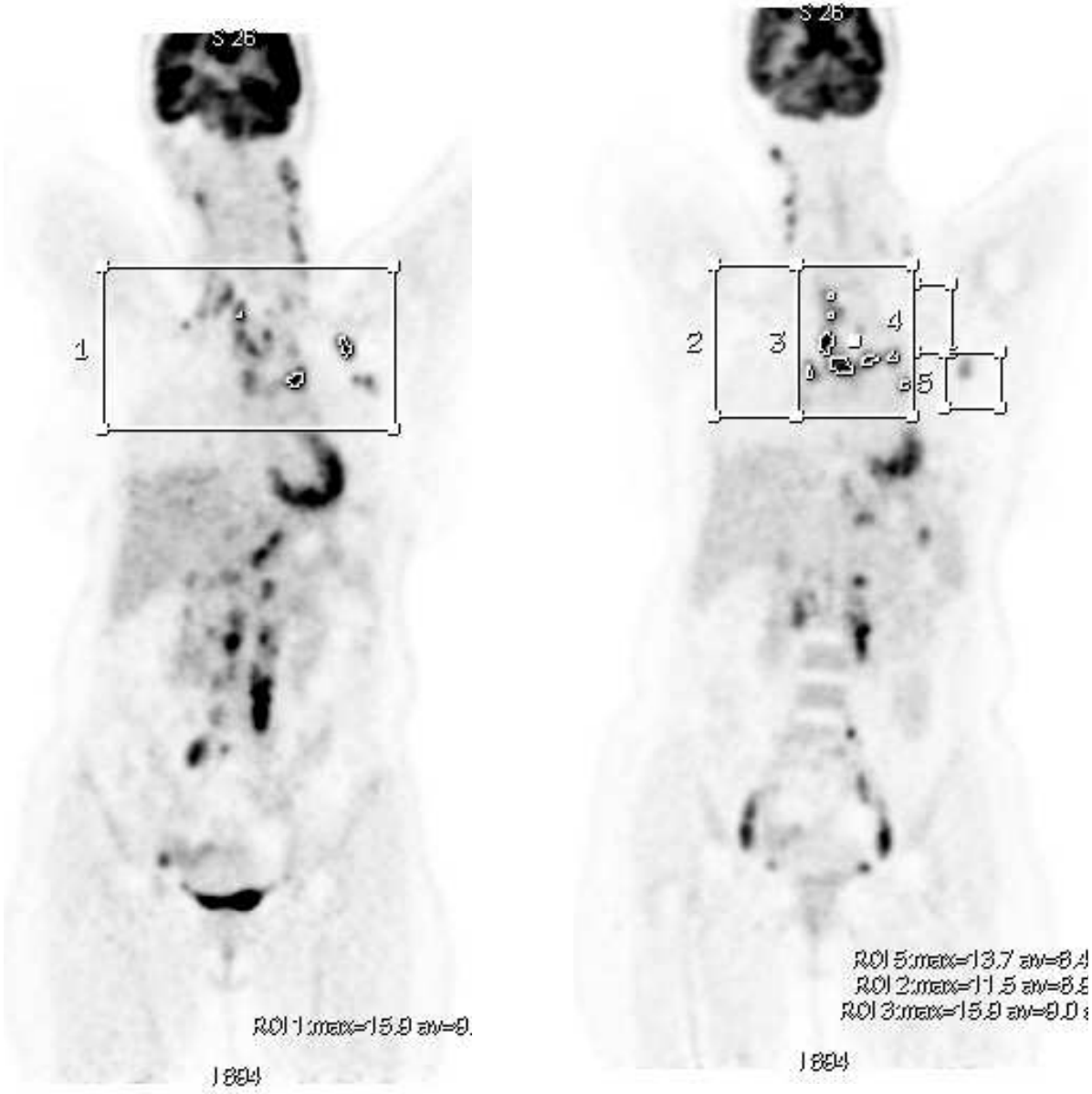
FDG PET and PET/CT: EANM procedure guidelines for tumour PET imaging: version 1.0

Ronald Boellaard · Mike J. O'Doherty · Wolfgang A. Weber · Felix M. Mottaghy · Markus N. Lonsdale · Sigrid G. Stroobants · Wim J. G. Oyen · Joerg Kotzerke · Otto S. Hoekstra · Jan Pruim · Paul K. Marsden · Klaus Tatsch · Corneline J. Hoekstra · Eric P. Visser · Bertjan Arends · Fred J. Verzijlbergen · Josee M. Zijlstra · Emile F. I. Comans · Adriaan A. Lammertsma · Anne M. Paans · Antoon T. Willemsen · Thomas Beyer · Andreas Bockisch · Cornelia Schaefer-Prokop · Dominique Delbeke · Richard P. Baum · Arturo Chiti · Bernd J. Krause

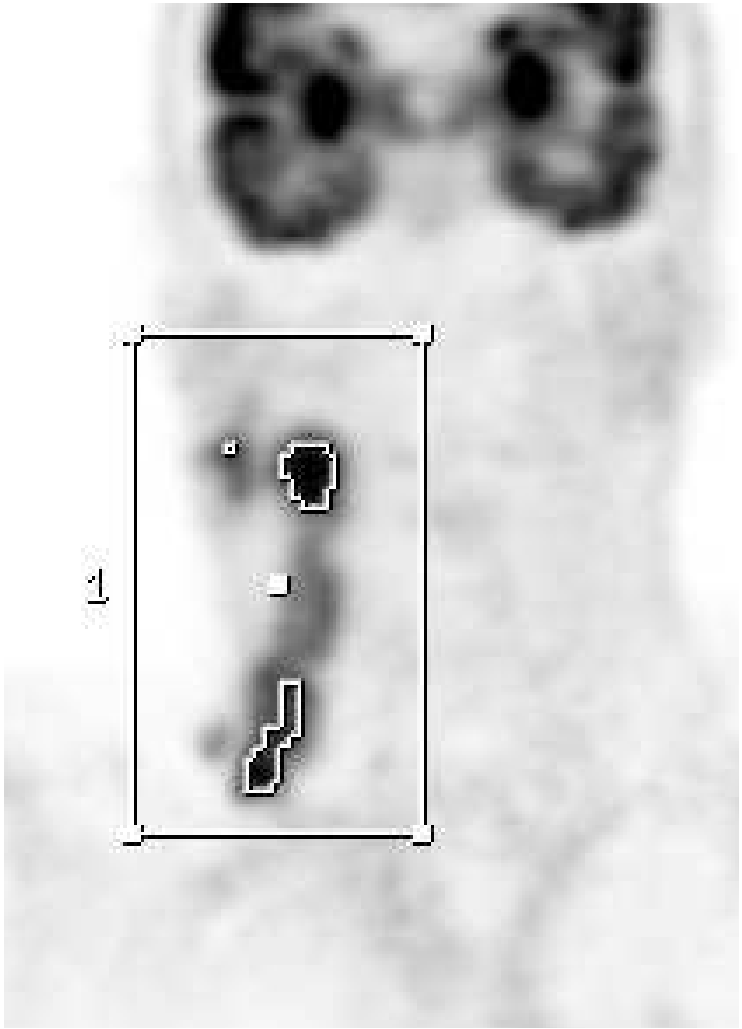
The isocontour described as A41 (41% of max pixel value)
•generally corresponds best with the actual dimensions of the tumour,
but only
•for higher tumour-to-background values and homogenous backgrounds

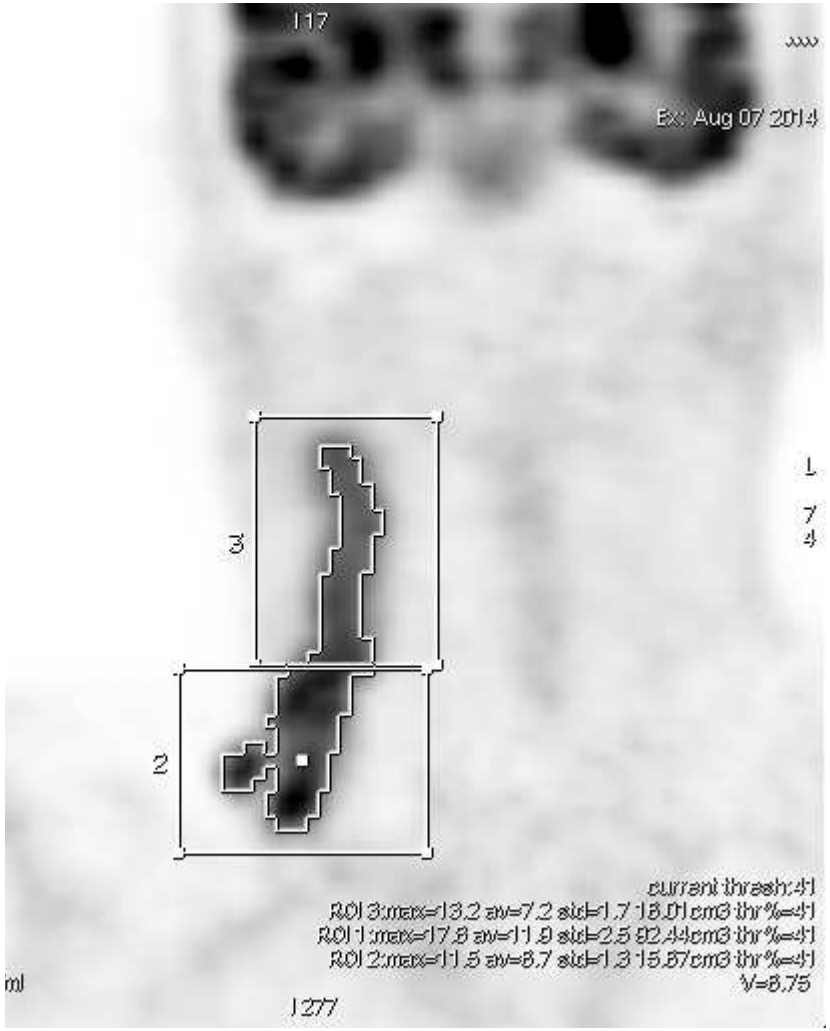
To determine TMTV0, volumes of interest (VOI) are identified by drawing spheres, cylinders or cubes around each focus of 18F-FDG uptake on pretreatment 18F-FDG PET/CT scans.

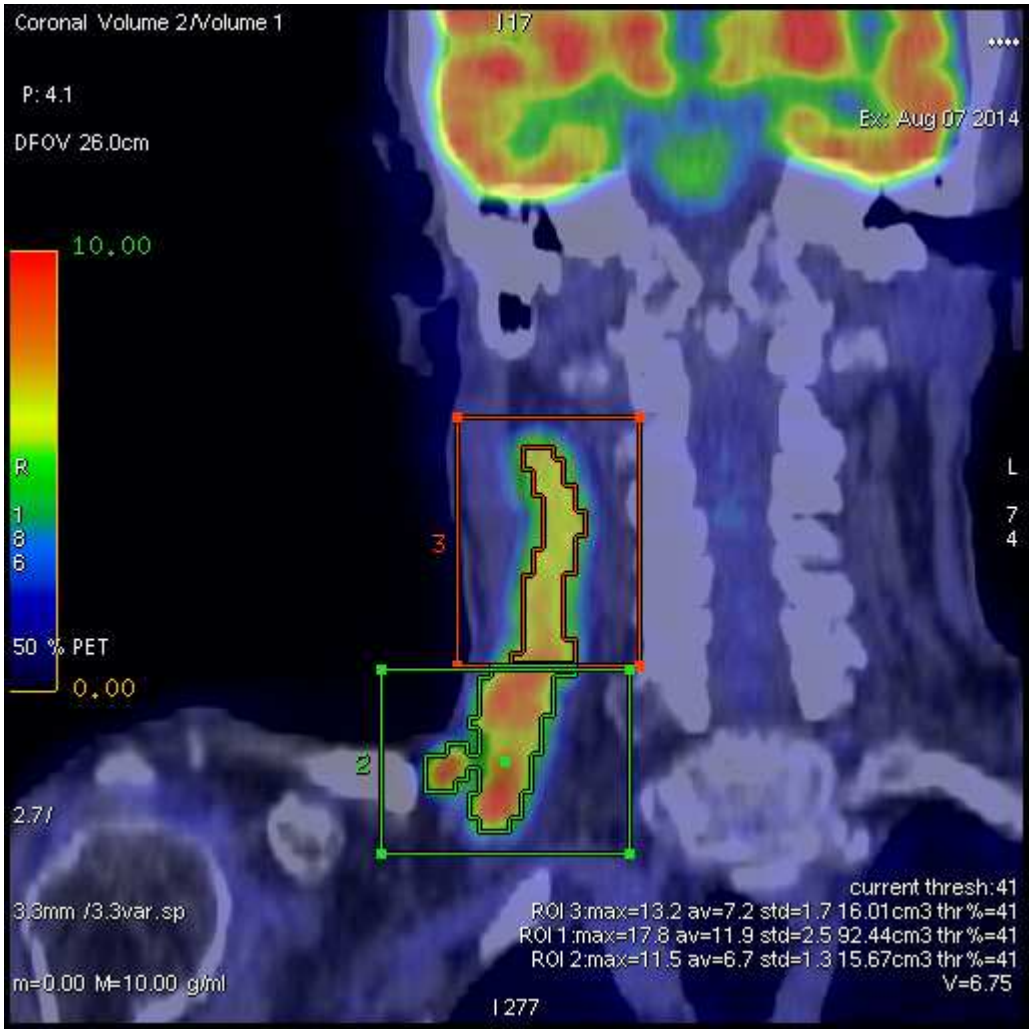
In each VOI, voxels with **41 %** or more of the SUVmax of the lesion are incorporated to define the volume of each individual lesion



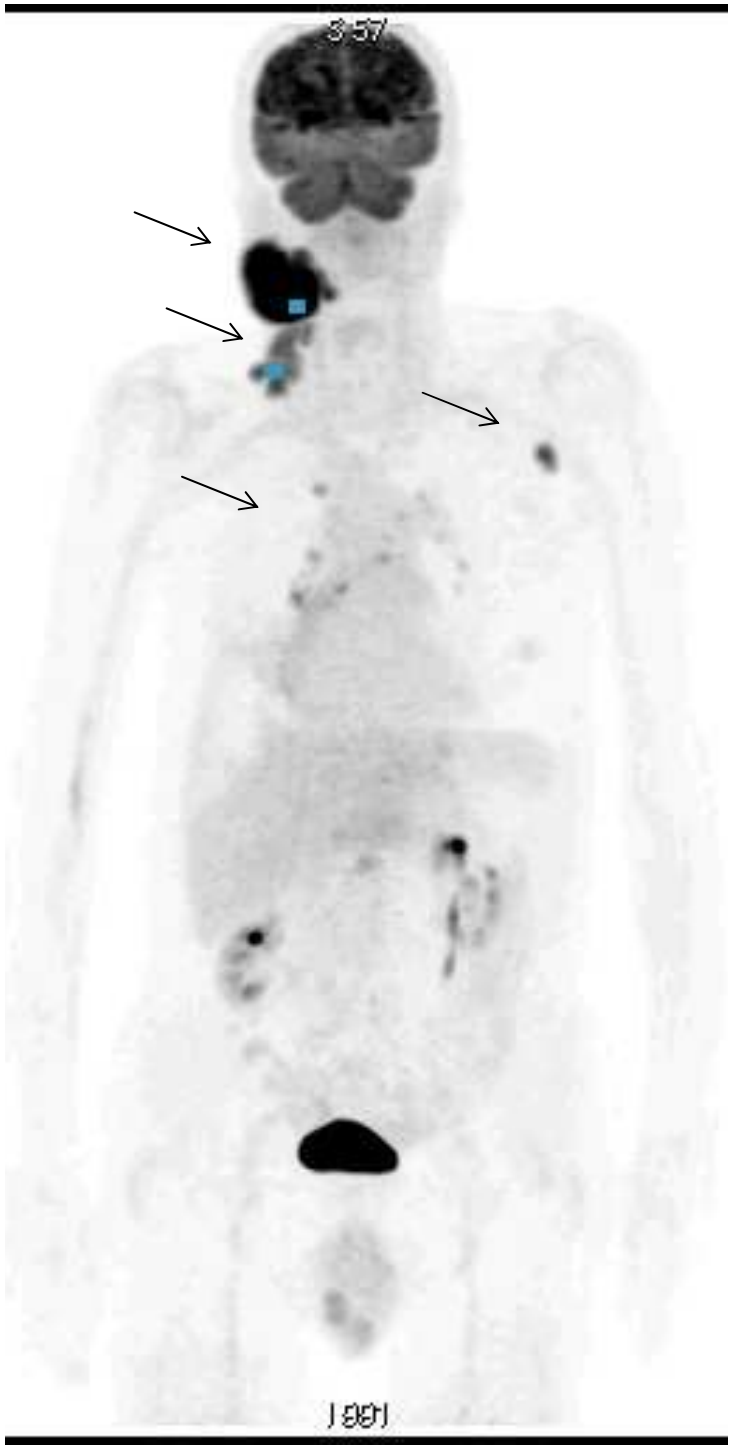
If the **uptake is heterogeneous**, high local uptake needs to be isolated in separate VOI to avoid underestimation of the tumour volume.



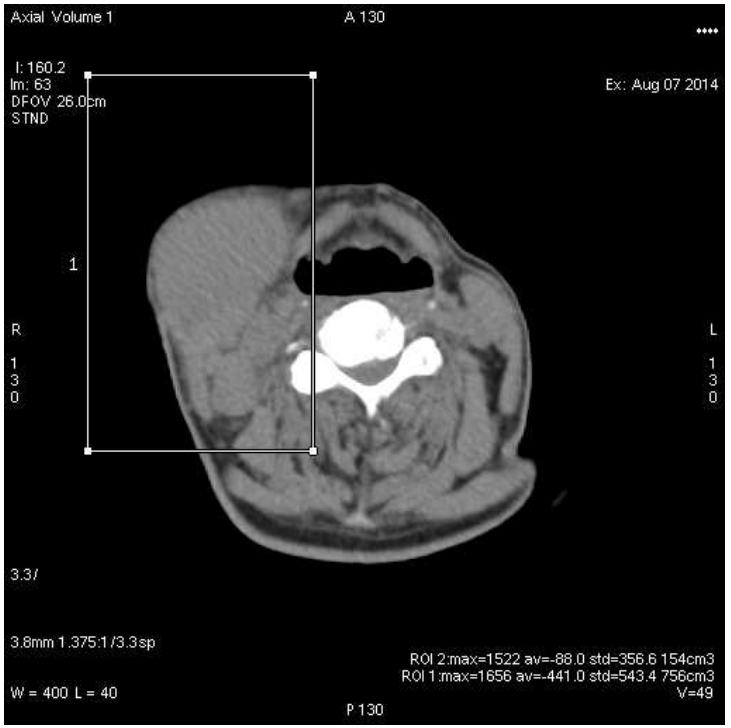


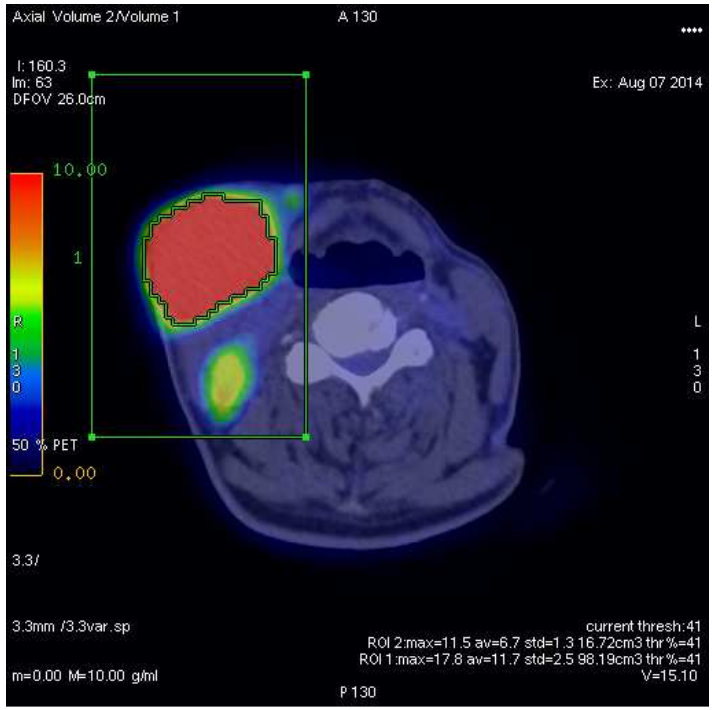

Coronal Volume 2/Volume 1
I 17
P: 4.1
DFOV 26.0cm
Ex: Aug 07 2014
10.00
R
1
8
6
50 % PET
0.00
3
2
L
7
4
2.7/
3.3mm /3.3var.sp
current thresh:41
ROI 3:max=13.2 av=7.2 std=1.7 16.01cm3 thr%=41
ROI 1:max=17.8 av=11.9 std=2.5 92.44cm3 thr%=41
ROI 2:max=11.5 av=6.7 std=1.3 15.67cm3 thr%=41
V=6.75
m=0.00 M=10.00 g/ml
I 277

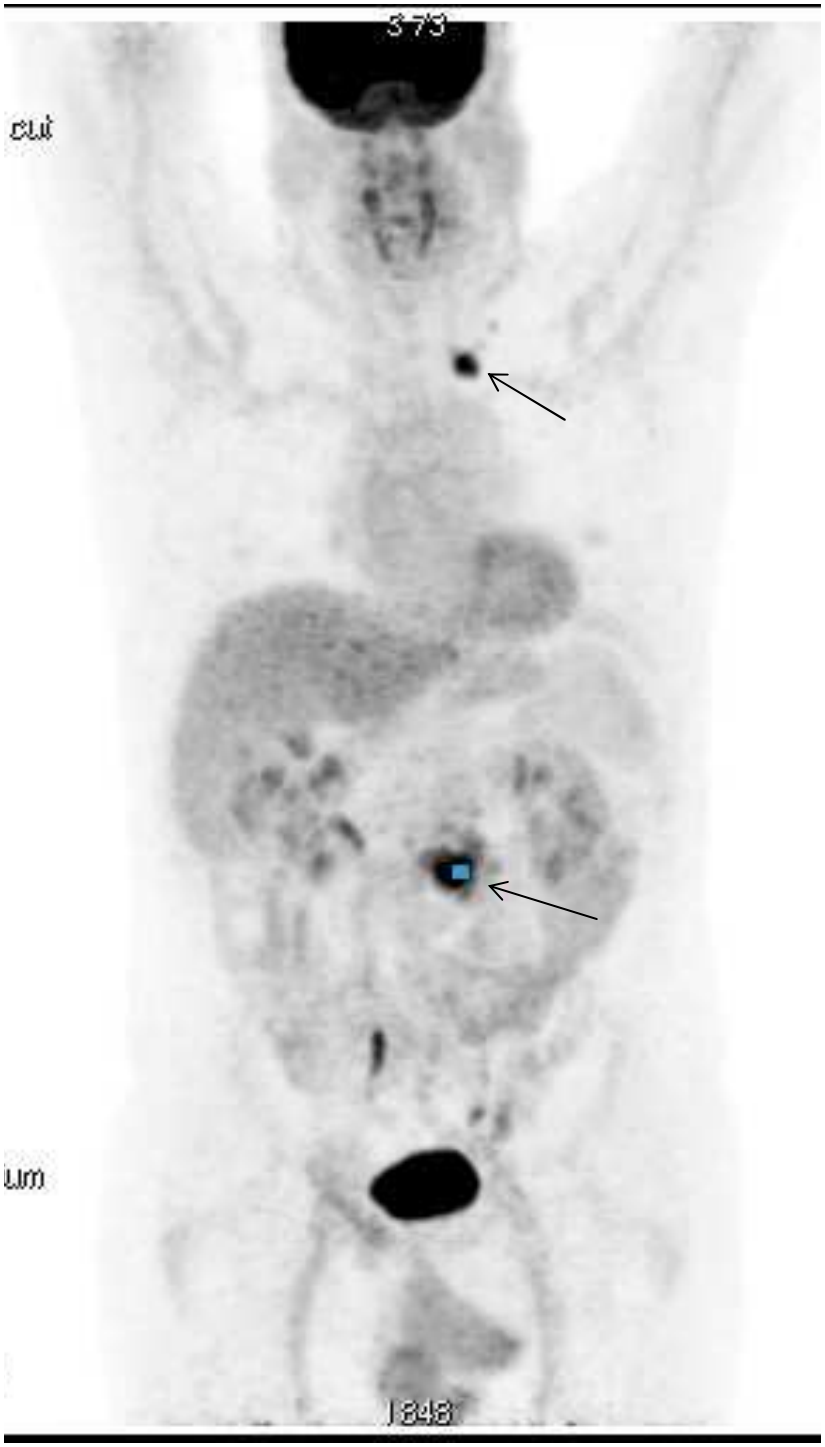

1
3
2

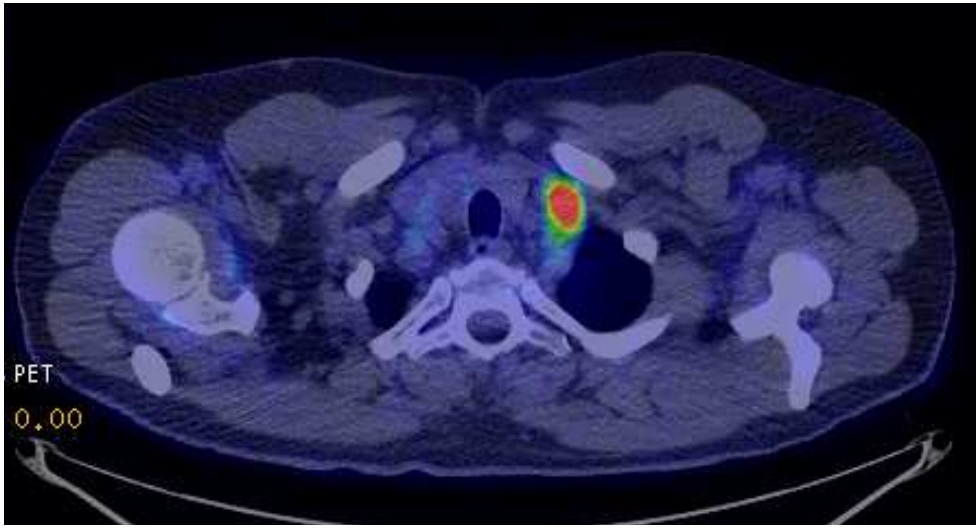


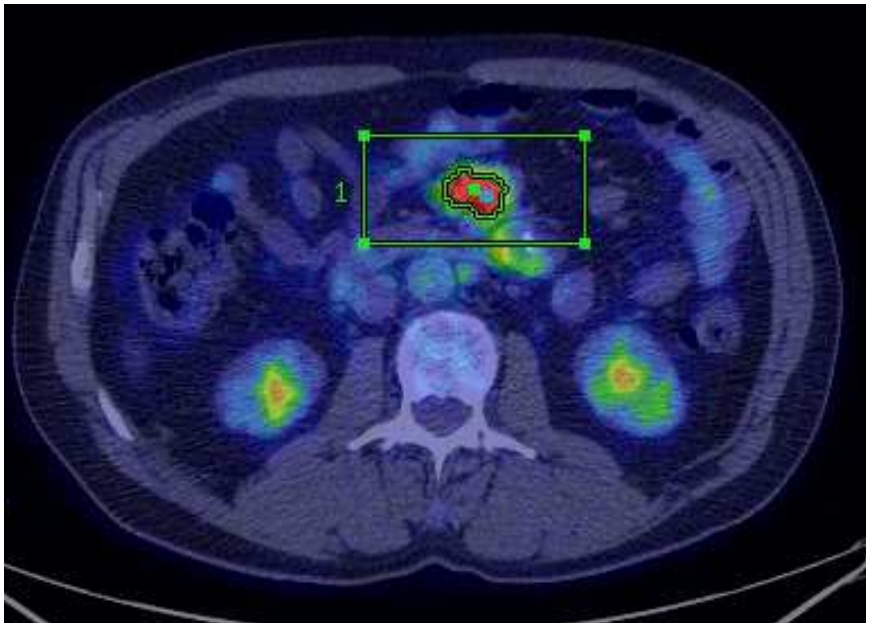
Different uptake











Different background

Problems

- **Extranodal involvement**
- **Bone marrow**
- **Spleen involvement**

Eur J Nucl Med Mol Imaging (2014) 41:1735–1743
DOI 10.1007/s00259-014-2783-x

ORIGINAL ARTICLE

Baseline metabolic tumour volume is an independent prognostic factor in Hodgkin lymphoma

Salim Kanoun · Cédric Rossi · Alina Berriolo-Riedinger · Inna Dygai-Cochet · Alexandre Cochet · Olivier Humbert · Michel Toubeau · Emmanuelle Ferrant · François Brunotte · René-Olivier Casasnovas

Received: 27 December 2013 / Accepted: 7 April 2014 / Published online: 9 May 2014

Problems

Extranodal involvement was considered in the volume calculation according to the following rules:

- the **liver, lung and bone marrow** were considered involved only if there was
- **focal uptake**, and the volume of each individual hypermetabolic lesion was
- computed in a **separate VOI**

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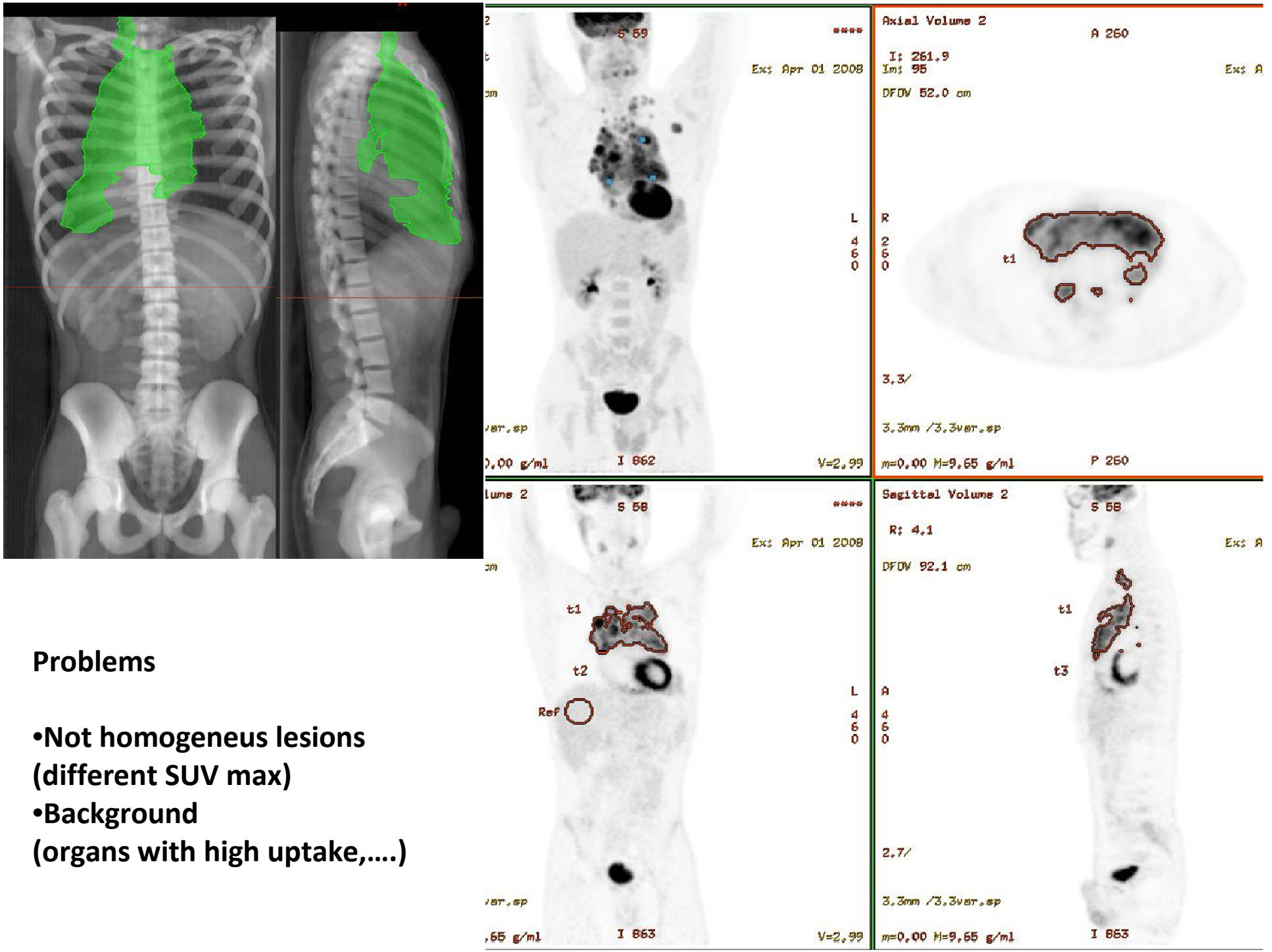
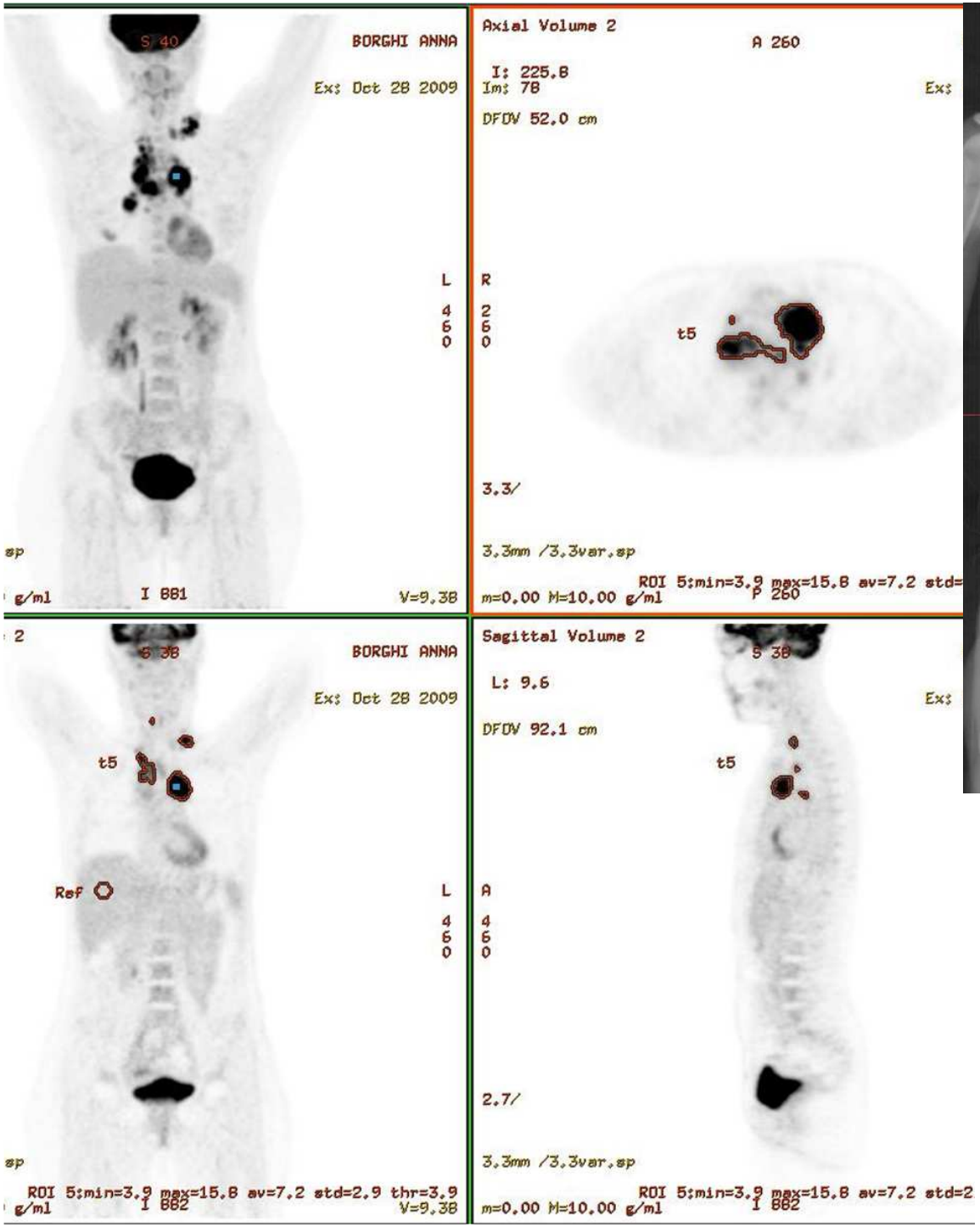
Received: 27 December 2013 / Accepted: 7 April 2014 / Published online: 9 May 2014

- **Homogeneous bone marrow** uptake was not included in the tumour volume
- **Spleen involvement** was considered if there was **focal uptake or diffuse uptake higher than 150 % of the liver background**



Problems

•Not homogeneus lesions (different SUV max)
•Background (organs with high uptake,….)



All the individual lesion volumes are added together to give the **total metabolic tumour volume at baseline (TMTV0).**

Total Lesion Glycolysis (TLG)

Calculation

mean SUV

x

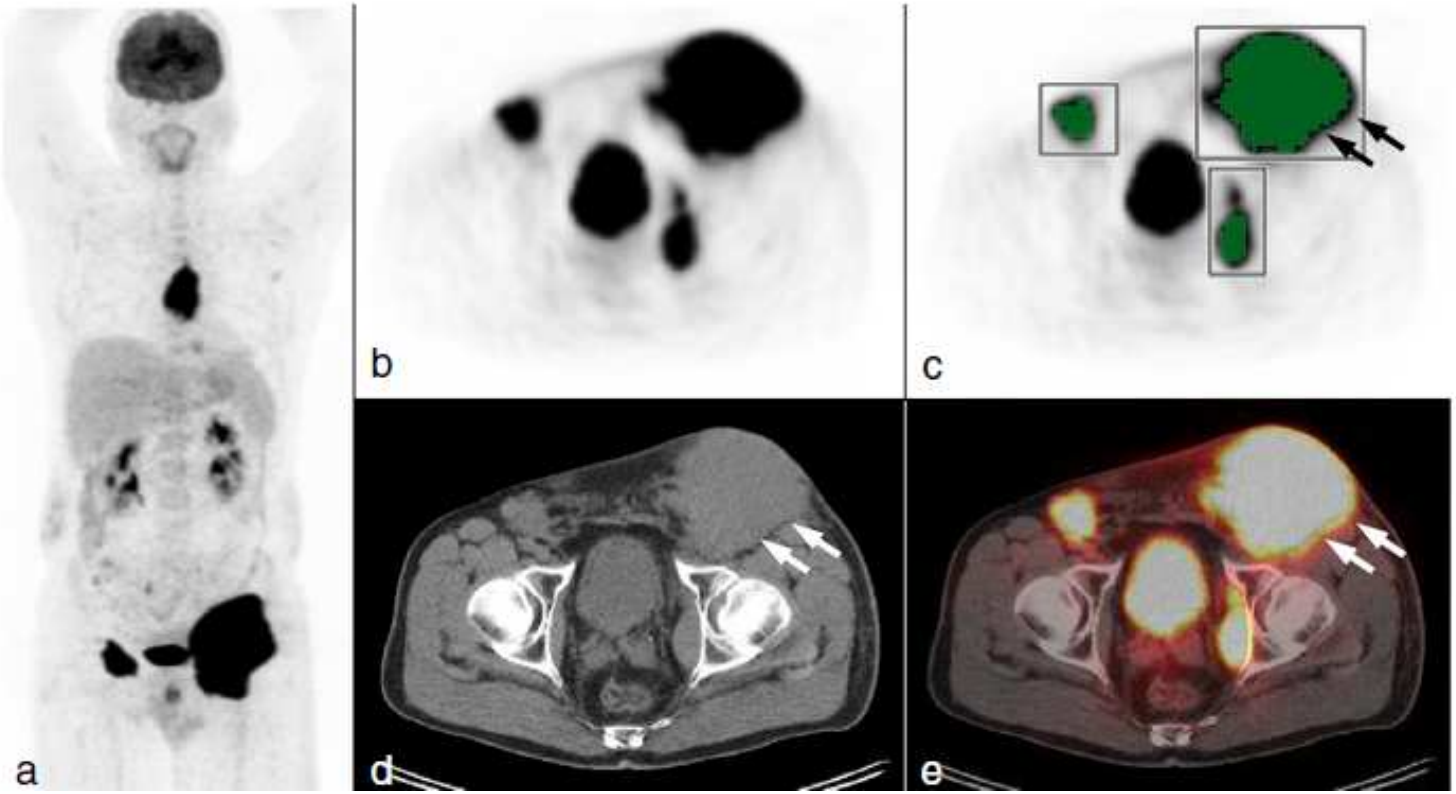
metabolic tumor volume

Original Article

Cancer March 15, 2013

Total Lesion Glycolysis in Positron Emission Tomography Is a Better Predictor of Outcome Than the International Prognostic Index for Patients With Diffuse Large B Cell Lymphoma

Tae Min Kim, MD, PhD[1]; Jin Chul Paeng, MD, PhD[2]; In Kook Chun, MD[2]; Bhumsuk Keam, MD[1]; Yoon Kyung Jeon, MD, PhD[3]; Se-Hoon Lee, MD, PhD[1]; Dong-Wan Kim, MD, PhD[1]; Dong Soo Lee, MD, PhD[2]; Chul Woo Kim, MD, PhD[3]; June-Key Chung, MD, PhD[2]; Il Han Kim, MD, PhD[4]; and Dae Seog Heo, MD, PhD[1]



Total Lesion Glycolysis (TLG)

mean SUV : advantages and problems of SUV

x

metabolic tumor volume

Conclusions

Metabolic Tumor Volume (MTV)

- Many software available
- Clear rules for definition are needed
- 41% threshold recommended for a better reproducibility

Total Lesion Glycolysis (TLG)

- Interesting
- Problems of SUV

Thanks for your attention

Calatrava Bridge – Reggio Emilia (Italy)