

Vor- und Nachteile der PET-CT Frankfurt, 6. Oktober 2007

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Verdankung:
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Inhalt

1. Grundzüge Molecular Imaging und PET-CT
2. Technik: Vor- und Nachteile
3. Klinik: Vorteile
4. CT Kontrastmittel in der PET-CT
5. Klinik: Nachteile und mögliche Verbesserungen



Nuclear medicine has been MI all along *Imaging with metabolic spies*

Imaging function is more difficult than
imaging anatomy

Medical imaging over the last 500 years

From the anatomy of the dead to bone
metabolism in the living



„contrast agent“ sensitivity in imaging *only nuclear (and optical) imaging have the sensitivity*

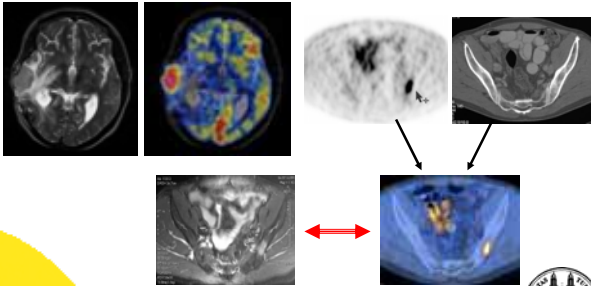
| Imaging-method | „contrast agent“- concentration (mol/kg kg) | spatial/temporal resolution mm/sec |
|------------------------|-----------------------------------------------------|------------------------------------------|
| Sono | 10^{-3} | 1 / 0.01 |
| CT | 10^{-3} | 0.6 / 0.1 |
| Conventional NM | 10^{-9} - 10^{-12} | 10 / 1 |
| PET | 10^{-9} - 10^{-12} | 5 / 5 |
| MRI | 10^{-5} | 0.1-1 / 0.05-0.2 |
| MRS | 10^{-5} | 10 / 100 |
| (optical imaging) | 10^{-9} - 10^{-12} | |



Anatomic framing of functional information *Software fusion is readily accomplished in the brain, but not so easily in the body*

Brain: SW integration easy

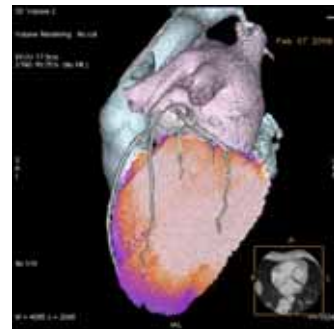
Brain: HW integration better



Once PET (SPECT) is anatomically referenced,
comparison of different studies easy




Hardware oder Software-Integration? *LAD-Stenose*



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Technik: Vorteile


1. Rascher Untersuchungsablauf
Teilkörper PET-CT Kopf-Os: < 30 Minuten
2. Flexibilität: viele mögliche Radiopharmaka
3. Anatomische Referenzierung der PET-Info
4. „kostenlose“ Absorptionskorrektur
-> konsistente Bilder
5. Effizienter Radiopharmakaverbrauch



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Technik: Nachteile


1. Ionisierende Strahlung
- FDG-PET ca. 10 mSv
- low dose CT ca. 1-2 mSv
2. Räumliche Auflösung
3. PET- und CT-System „blockieren“ sich gegenseitig
- Problem aller „dual-modality“ Systeme
4. Spezifität von FDG (ebenfalls Entzündungen)
5. Kosten



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Inhalt

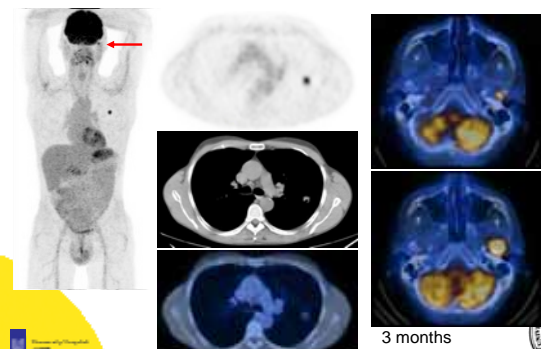
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PET adds sensitivity to CT

Goerres GW, Kamel E, Seifert B, Burger C, Buck C, Hany TF, von Schulthess GK. J Nucl Med 2002; 43:1469-1475.



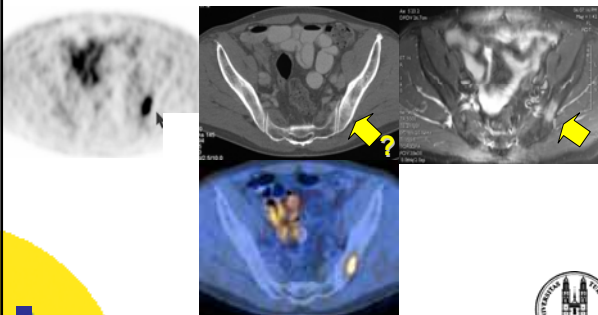

3 months post therapy



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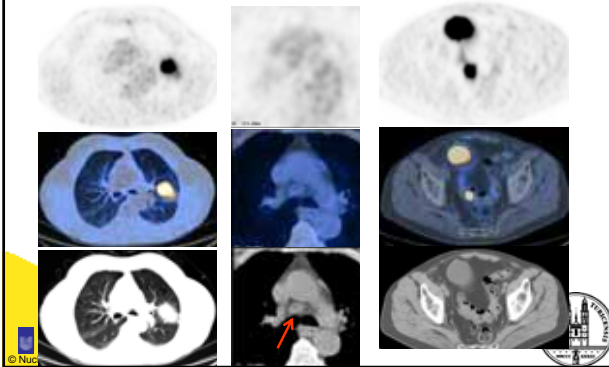
Improved sensitivity of PET-CT

We know that CT misses lesions
PET needs no arrow, it is the arrow !

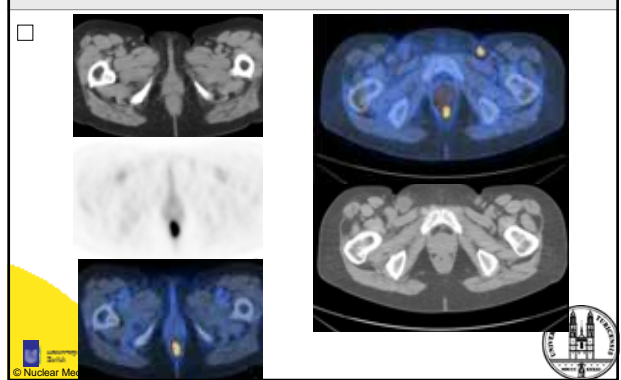



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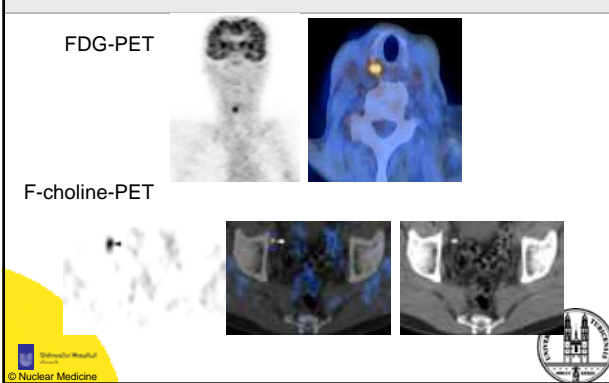
We know that we need to work up bowel foci
Incidence ~3%, around 2% pre- or cancerous lesions
E. Kamel et al., J Nucl Med 2004



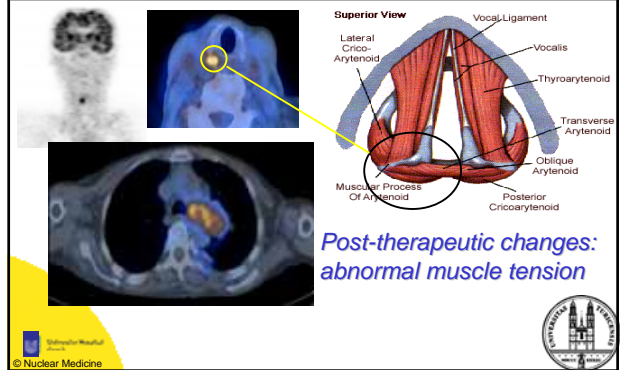
PET adds specificity to CT
Improved specificity over CT for lesion characterization



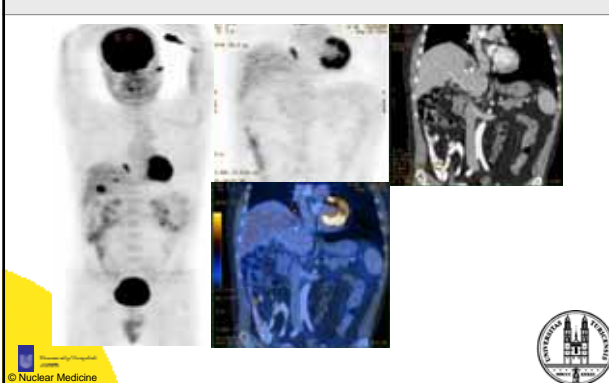
We know that anatomic referencing is necessary
improved specificity over PET for lesion characterization



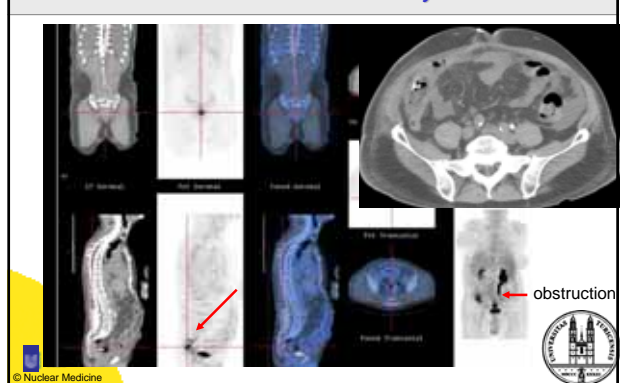
CT adds specificity to PET
Kamel EM, Goerres GW., Burger C, von Schulthess GK, Steinert HC. Radiology 2002; 224:153-158.



CT adds specificity to PET
Is the lesion in the chest or in the liver?

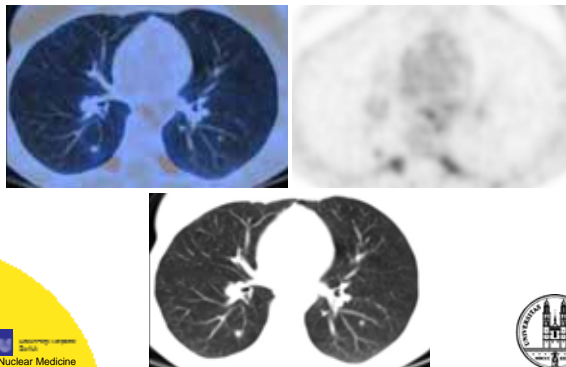


CT adds specificity of PET: other findings
Cause of obstruction seen on CT only



CT adds sensitivity to PET / limitations

Breast cancer metastases noted on CT only

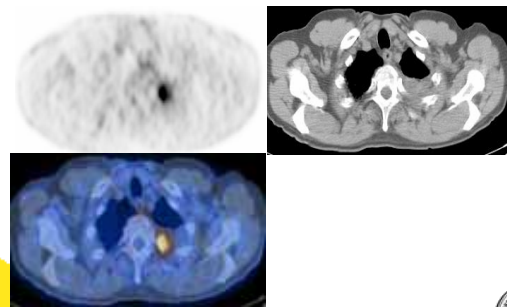


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Data suggest: PET-CT improves T Staging in NSCLC

D. Lardinois, W. Weder, T.F. Hany, E.M. Kamel, S. Korum, B. Seifert, G.K. von Schulthess, H.C. Steinert. *N Engl J Med.* 2003; 348(25):2500-7



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Improved T, N staging in NSCL with PET/CT

D. Lardinois, W. Weder, T.F. Hany, E.M. Kamel, S. Korum, B. Seifert, G.K. von Schulthess, H.C. Steinert. *N Engl J Med.* 2003; 348(25):2500-7

50 patients prospectively evaluated
PET/CT additional information in 41% over PET + CT

| T stage | Paired Sign Test | P-value |
|---------|-------------------|---------|
| | PET/CT vs. CT | 0.001* |
| | PET/CT vs. PET | <0.001* |
| | PET/CT vs. PET+CT | 0.013* |

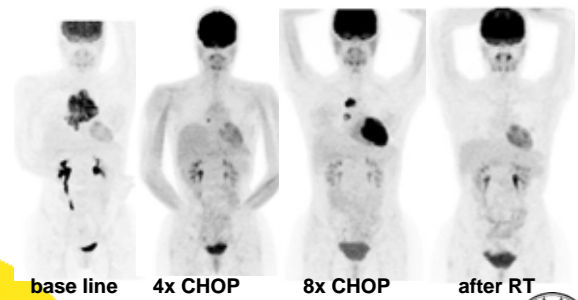
| N stage | Paired Sign Test | P-Value |
|---------|-------------------|---------|
| | PET/CT vs. CT | 0.12 |
| | PET/CT vs. PET | 0.013* |
| | PET/CT vs. PET+CT | 0.021 |

*significant after Bonferroni correction

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Patient with Hodkin Lymphoma

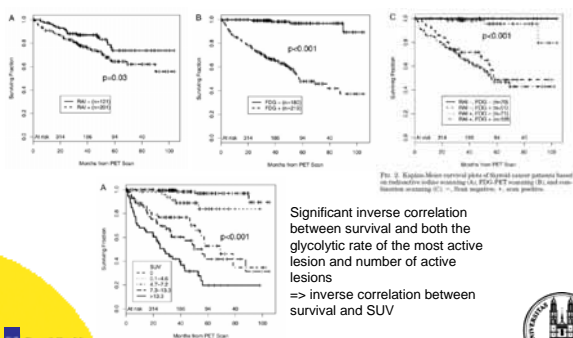


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Prognostic value of FDG-PET

Robbins et al., *J Clin Endocr. Metab* 91: 498-505, 2006



Significant inverse correlation between survival and both the glycolytic rate of the most active lesion and number of active lesions
=> inverse correlation between survival and SUV

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Therapy monitoring

PET and PET-CT have prognostic value

Substantial clinical data exist on the capability of PET (and PET-CT) to stratify outcome

- lymphoma
Jerusalem G. Ann Oncol. 2003 Jan;14(1):123-30
- gastrointestinal stromal tumors
Goerres GW et al. Europ J NMMI 2005; 32:153-162,
- non-small cell lung cancer
Mac Manus MP et. al. J Clin Oncol. 2003; 21(7):1285-92.
- rectal cancer
Kalff V et al. J Nucl Med 2006; 47:14-22
- esophageal tumor response
Björn LDM et al. Ann Surg 2005; 233:300-309
- differentiated thyroid carcinoma
Robbins et al., J Clin Endocr. Metab 2006; 91: 498-505,

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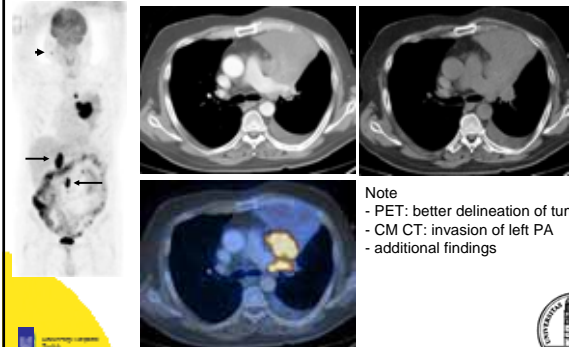
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NSCLC staging of primary tumor

invasion of left pulmonary artery: need X-ray CM

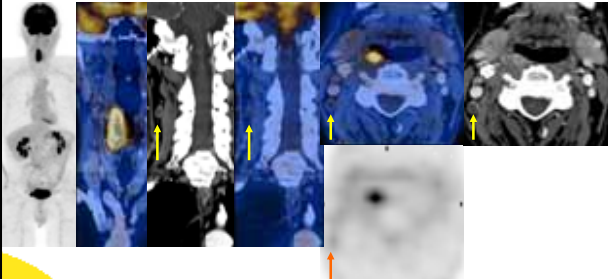


Note
- PET: better delineation of tumor
- CM CT: invasion of left PA
- additional findings



Limitations of PET: CT helps sometimes

63 year old male with hypopharyngeal carcinoma



Centrally necrotic lymph node (yellow arrows)
which would not have been recognized as
pathological on PET only (red arrow)



Vorteile Klinik

1. Höhere Sens. / Spec. als PET oder CT alleine
2. In weiten Bereichen Tu-imaging MR überlegen
3. Prognostische Aussagekraft dokumentiert
4. Volle CT-Protokolle möglich inkl. KM-CT, Koro-CT
5. One-stop shop



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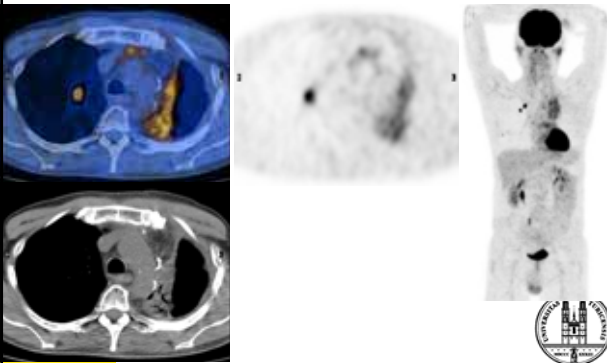
Nachteile Klinik

1. Ev. eingeschränkte Sensitivität bei osteoblastischen Knochen-metastasen
2. FDG ist nicht spezifisch für Tumoren
3. Substantielle FP Rate bei „Anfängern“
4. PET ± bei Prostataca. und anderen Tumoren
5. Eingeschränkte Sensitivität Hirn, Nieren, Blase



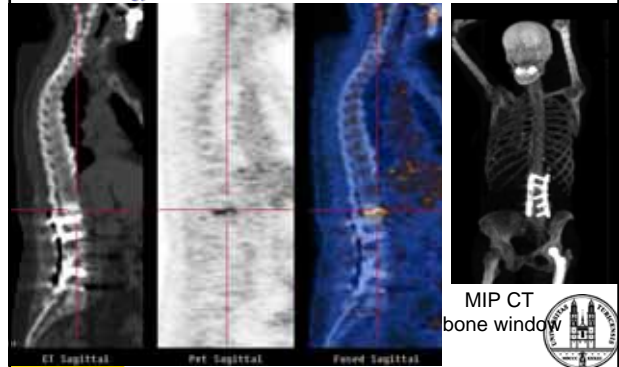
Bronchial carcinoma

Recurrence and persistence of RT field inflammation



PET and PET/CT in Osteosynthesis infection

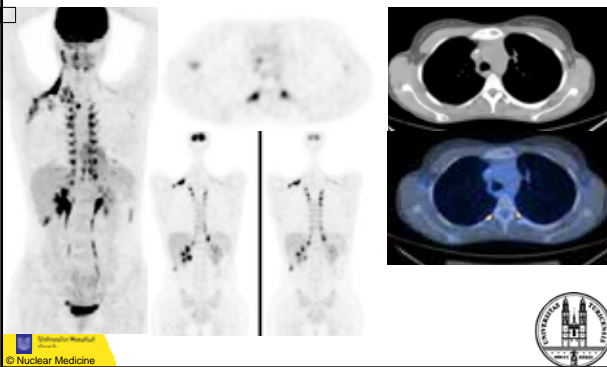
Schiesser M, Stumpe K, Trezn O, Kossmann T, von Schulthess GK. Radiology 2002; 226:391-398.



MIP CT
bone window

Patient Hodgkin IIB s. p. ChemoRx and RT

Hany TF, Gharehpapagh E, Kamel EM, Buck A, Himms-Hagen J, von Schulthess GK. Europ J Nucl Med 2002; 29:1393-1398.

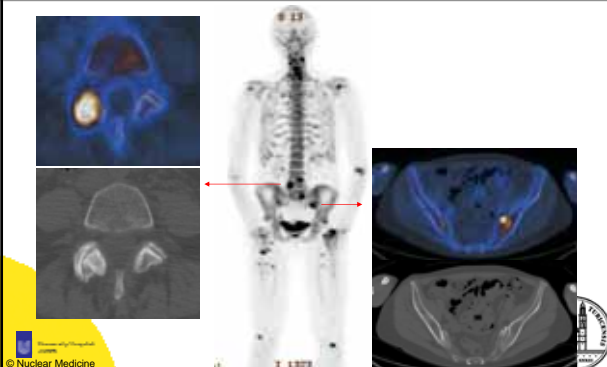


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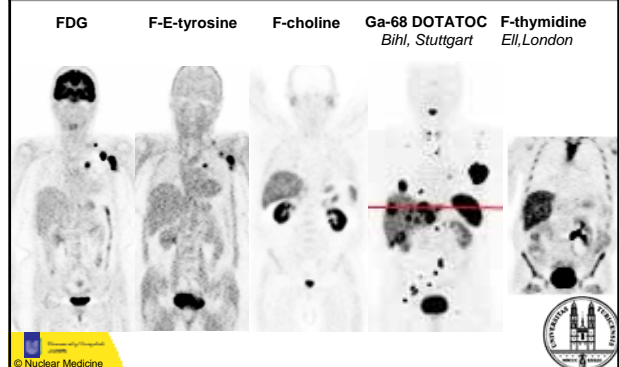
Fluoride-PET-CT

Intervertebral and ilio-sacral joint osteo-arthritis



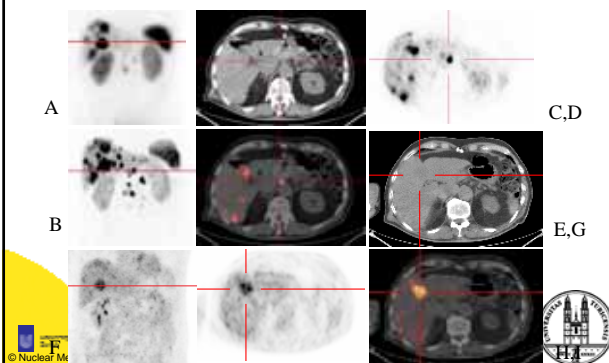
Each tracer is a „new imaging modality“

Usefulness of various compounds for body imaging ?



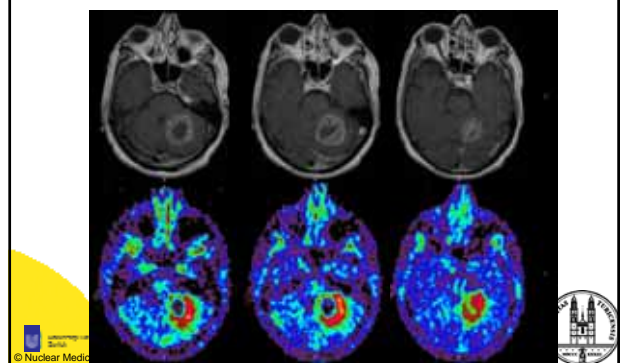
In-111 octreotide

Multiple metastases of carcinoid tumor
Courtesy of H. Bihl, Stuttgart



Glioblastoma post-op

F-ethyl tyrosine PET: recurrence?



Zusammenfassung

1. FDG-PET-CT bringt im Tumorstaging und der Therapiekontrolle viele Vorteile
2. PET-CT kann mit voll ausgebauten CT-Protokollen gefahren werden
3. Die Nachteile von PET-CT halten sich in Grenzen
4. Andere Radiopharmaka werden neue Diagnostikbereiche erschliessen und einen Teil der bestehenden Mängel ausmerzen

