中华医学会核医学分会
技术与继续教育学组

中华医学会核医学分会第十一届委员会
技术与继续教育学组
系列专家讲座

【病案分析】前列腺癌PET/CT
多模态显像一例

程祝忠

四川省肿瘤医院 影像核医学诊治部

PET/CT中心

2018年6月5日

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- 影像核医学诊治部技术教育培训部主任、PET/CT中心主任
- 中华医学会核医学分会第十一届委员会技术与继续教育学组委员
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病史

- 老年男性，57岁，慢性病程

- 主诉：
  前列腺癌电切术后放疗8年余
  PSA进行性升高半年

病史

- 现病史：

8年+，外院体检发现TPSA 45 ng/ml 就诊于外院确诊前列腺癌，行TURP术后病理诊断前列腺癌（Gleason评分不详）。术后行根治性放射治疗（具体不详），并行戈舍瑞林+比卡鲁胺内分泌治疗至今。后复查TPSA降至0.01 ng/ml。此后患者定期复查PSA，自述均较低。

3年+，患者复查PSA逐渐升高，至TPSA 6ng/ml后复查骨扫描提示腰1、4椎体转移，遂针对腰椎转移灶行放疗（具体计量不详），放疗后患者TPSA＜ 0.1 ng/ml。

半年前，患者PSA进行性升高，2016-3-8来我院行PET/CT，提示前列腺癌术后，腺体代谢轻度增高，请随访。L1椎体局部高密度影，结合病史考虑骨转移治疗后改变。予以继续随访观察。

1月+外院TPSA 3.75 ng/ml，盆腔MRI提示前列腺不大，左侧2-4点钟位强化结节影，较旧片增大，左侧精囊腺受侵可能。

2016-6-2再次入我院行SPECT提示全身骨现象未见明显异常征象。患者为求进一步诊治入院。

病史

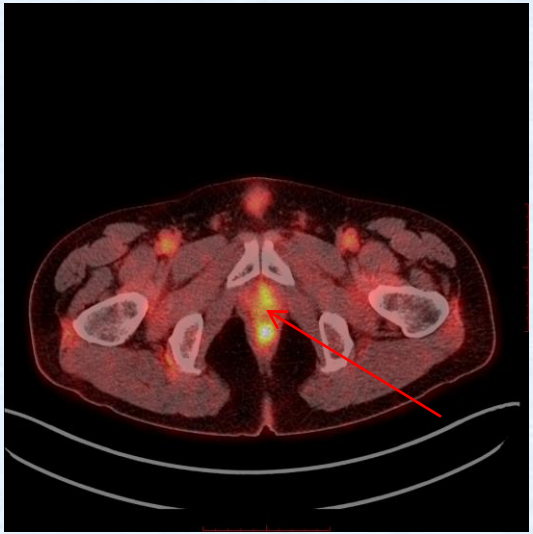
- 查体

前列腺I度大小，质硬，表面光滑，左右侧叶未扪机结节，无压痛，指套无血染。

- 2016-6-7 TPSA 5 ng/ml

- 2016-6-22行LRP，术后病理提示前列腺癌，Gleason评分：5+4=9分，可见高级别PIN结构，脉管内查见癌栓。

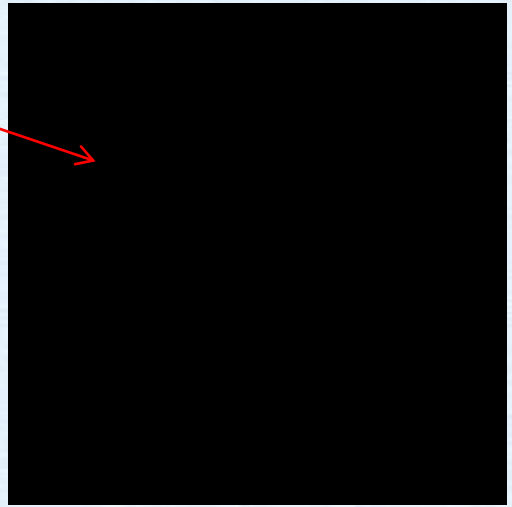
影像学---^{18}F-FDG PET/CT

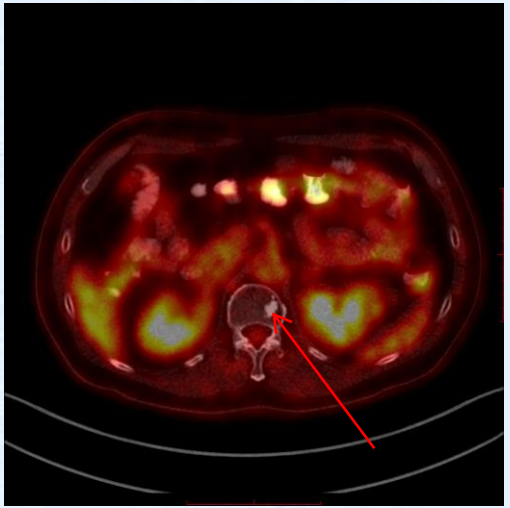


2016-3-8　前列腺癌术后，左侧腺体代谢轻度增高

（此处应该诊断为左侧复发）

影像学---^{18}F-FDG PET/CT



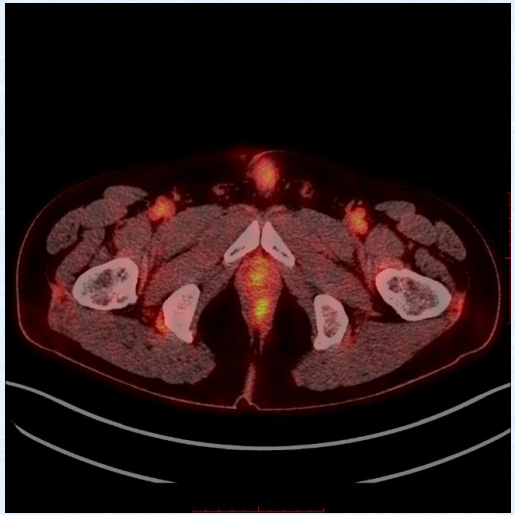


2016-3-8

L1椎体局部高密度影，结合病史考虑骨转移治疗后改变

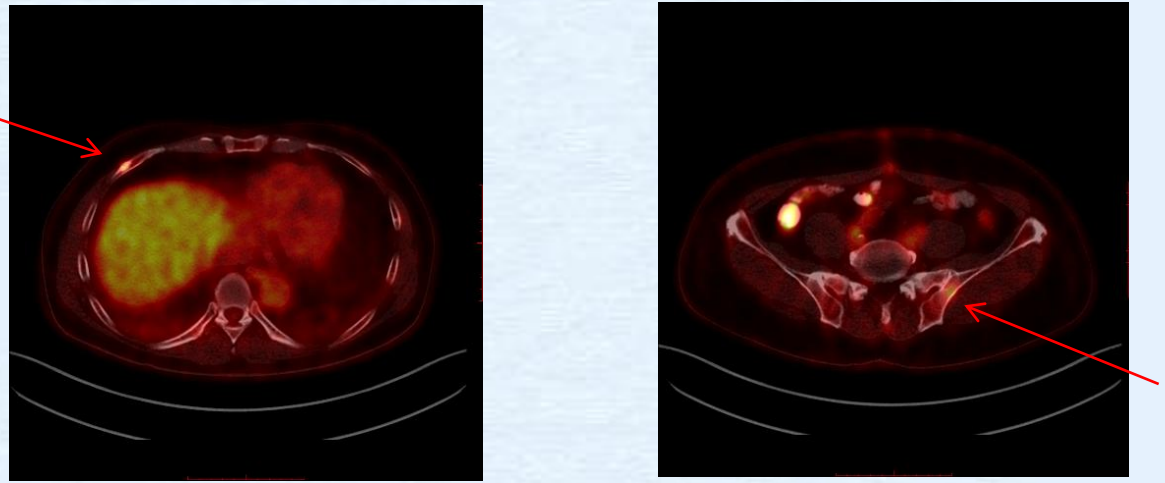
右侧第9前肋局部高密度影，最大SUV为2.5，转移待排

影像学---^{18}F-FDG PET/CT



2016-9-21，患者因Pca RP术后3月+，血TPSA升高门诊入我院再次行
^{18}F-FDG PET/CT显示前列腺呈术后改变，术区未见复发征象

影像学---^{18}F-FDG PET/CT



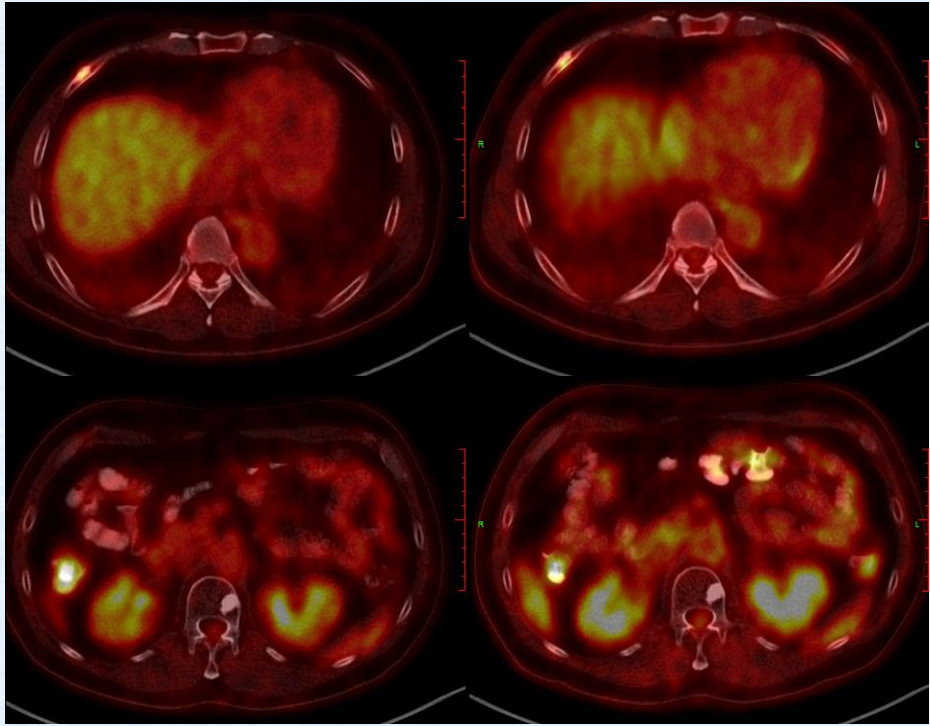
右侧第9前肋局部骨质密度增高，最大SUV为2.7

左侧髂骨局部骨质密度稍增高，最大SUV为2.3

影像学---前后两次^{18}F-FDG PET/CT比较

第2次

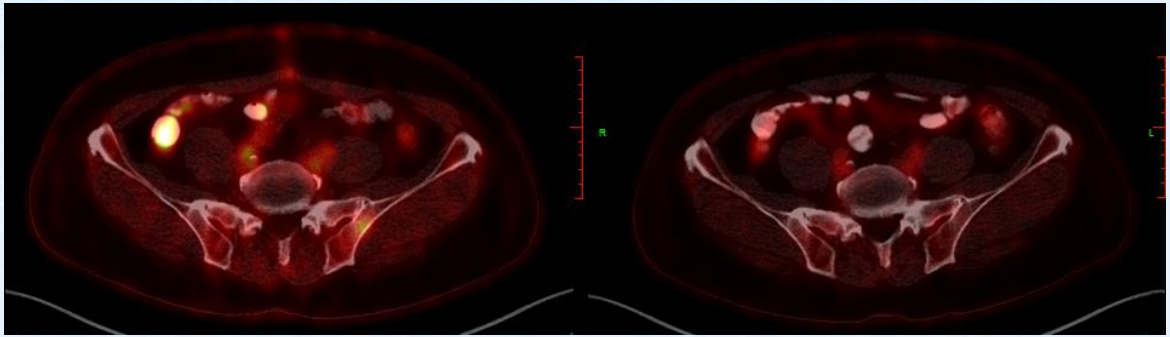
第1次



第2次　　第1次

腰1椎体，右侧第9前肋局部高密度影，较前未见明显变化

影像学---前后两次^{18}F-FDG PET/CT比较



第2次　　第1次

左侧髂骨局部代谢增高，最大SUV为，较前新增右侧第9前肋及左侧髂骨局部骨质密度不均匀伴代谢增高，性质：骨转移？或其它？

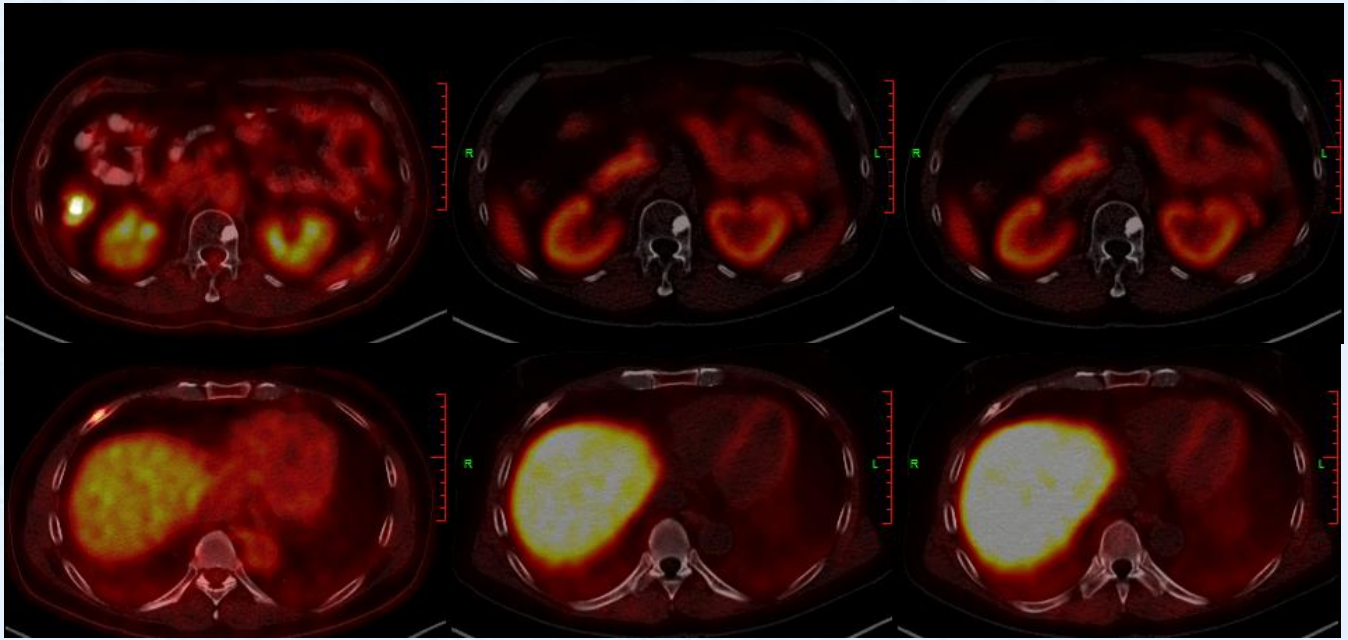
⇩

^{11}C-CHO 及^{11}C-ACETATE PET/CT

影像学---3种PET/CT比较

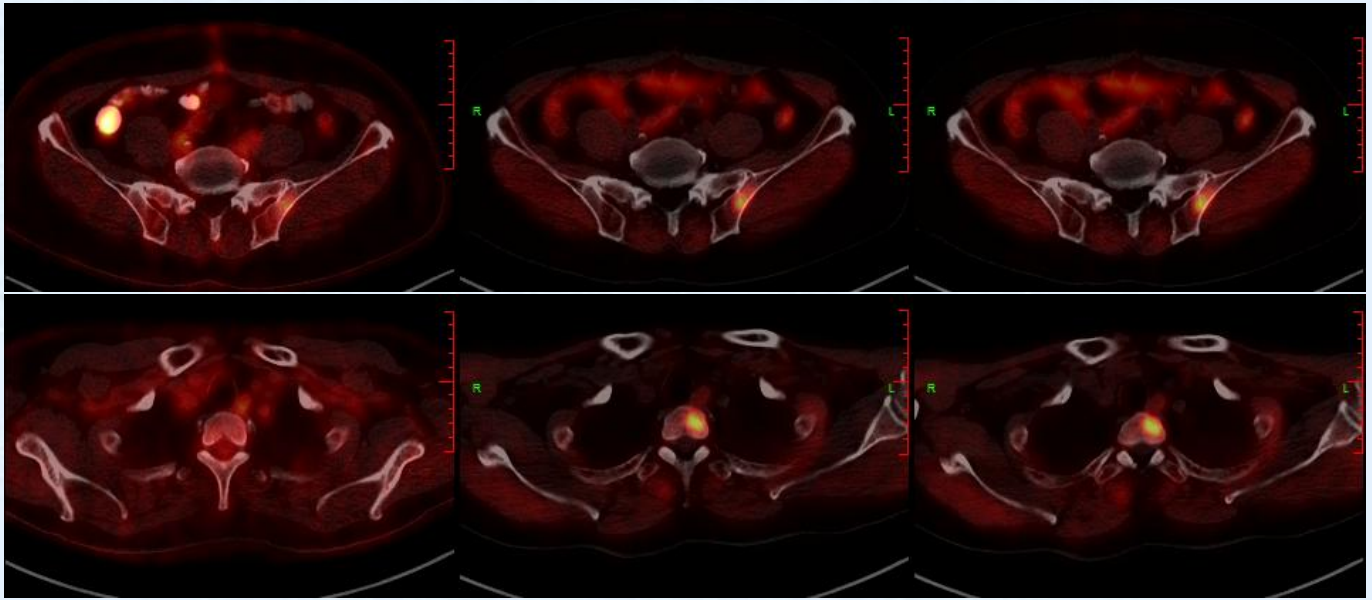
^{18}F-FDG　　^{11}C-CHO　　^{11}C-ACETATE

影像学---3种PET/CT比较



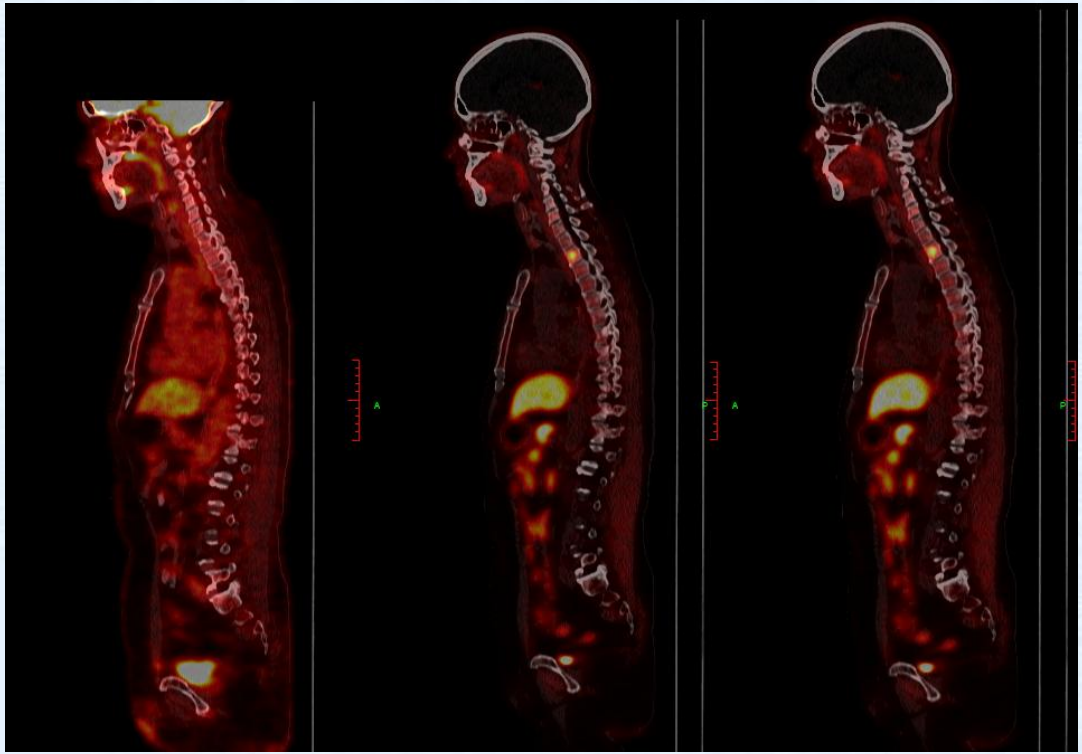
^{18}F-FDG　　^{11}C-CHO　　^{11}C-ACETATE

影像学---3种PET/CT比较



^{18}F-FDG　　^{11}C-CHO　　^{11}C-ACETATE

影像学---3种PET/CT比较



^{18}F-FDG　　^{11}C-CHO　　^{11}C-ACETATE

胆碱及乙酸盐示胸2椎体代谢增高，考虑转移

本次诊断：患者PSA升高，术区未见异常

胸2椎体局部	左髂骨局部	右侧第9前肋局部
^{18}F-FDG 未显影	^{18}F-FDG 显影	^{18}F-FDG 显影
^{11}C-CHO 显影	^{11}C-CHO 显影	^{11}C-CHO 显影
^{11}C-ACETATE 显影	^{11}C-ACETATE 显影	^{11}C-ACETATE显影
⇩	⇩	⇩
骨转移	骨转移	陈旧性改变

前列腺癌分子影像学新进展

一、Hyperpolazised MRI

超极化MRI是一种新型的分子显像技术，可用来检测内生生物分子的代谢。

Chen、Lupo等人的临床前老鼠Pca模型显示超极化乳酸MRI在肿瘤区域信号增加；乳酸及丙酮酸MRI信号会随疾病进展增加，治疗后信号均下降。

Nelson等人的一项前瞻性人体试验显示超极化丙酮酸MRI信号增高区域与活检恶性区域一致。

前列腺癌分子影像学新进展

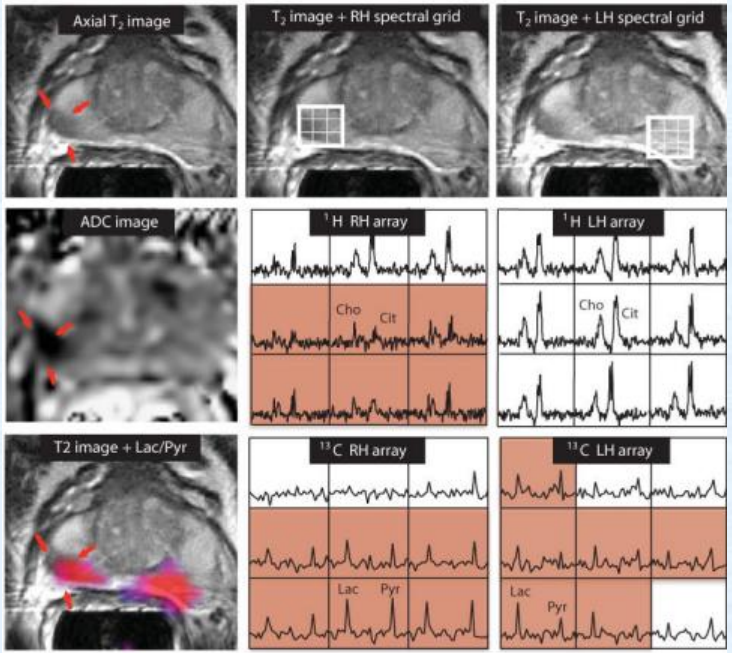


Fig. 4. 2D single–time point MRSI data
Images were obtained from a patient with serum PSA of 9.5 ng/ml, who was diagnosed with bilateral biopsy-proven Gleason grade 3 + 3 prostate cancer and received the highest dose of hyperpolarized [1-13C]pyruvate (0.43 ml/kg). The axial T2-weighted image shows a unilateral region of reduced signal intensity (red arrows), which is consistent with a reduction in the corresponding ADC. The 1H spectral arrays supported these findings, with voxels with reduced citrate and elevated choline/citrate (highlighted in pink) on the right side of the gland and voxels with normal metabolite ratios on the left side. The 13C spectral arrays show voxels with elevated levels of hyperpolarized [1-13C]lactate/[1-13C]pyruvate (highlighted in pink) on both the right and left sides of the prostate. The location of colored regions in the metabolite image overlay had a ratio of [1-13C]lactate/[1-13C]pyruvate greater than or equal to 0.6.

Nelson SJ et al. Metabolic imaging of patients with prostate cancer using hyperpolarized [1-(1)(3)C]pyruvate. Sci Transl Med. 2013;5(198):198ra108.

前列腺癌分子影像学新进展

二、^{11}C-CHO PET/CT

CHO代谢显像的优点是不经肾排泄，对泌尿系统肿瘤的检出不受尿液中放射性的影响（虽然膀胱和直肠可有不同程度的示踪剂浓聚，但程度较低，不干扰前列腺显示）。

用于检测前列腺癌局部治疗后生化复发患者，帮助区别局限性的、区域的以及远处复发，指导制定后续治疗方案。

CHO显像阳性与PSA倍增时间及PSA速率相关，因此对于生化复发明确的患者意义较大。

Giovacchini G et al. PSA doubling time for prediction of [(11)C]choline PET/CT findings in prostate cancer patients with biochemical failure after radical prostatectomy. Eur J Nucl Med Mol Imaging. 2010;37(6):1106−16.

^{11}C-CHO PET/CT可预测复发患者生存期

J Nucl Med. 2015 Dec;56(12):1836-42. doi: 10.2967/jnumed.115.163741. Epub 2015 Sep 24.

Radiation Treatment of Lymph Node Recurrence from Prostate Cancer: Is 11C-Choline PET/CT Predictive of Survival Outcomes?

Incerti E[1], Fodor A[2], Mapelli P[1], Fiorino C[3], Alongi P[1], Kirienko M[4], Giovacchini G[5], Busnardo E[1], Gianolli L[1], Di Muzio N[2], Picchio M[6].

Author information

Abstract

PET/CT is a valuable tool to detect lymph node (LN) metastases in patients with biochemical failure after primary treatment for prostate cancer (PCa). The aim was to assess the predictive role of imaging parameters derived by (11)C-choline PET/CT on survival outcomes-overall survival, locoregional relapse-free survival, clinical relapse-free survival (cRFS), and biochemical relapse-free survival (bRFS)-in patients treated with helical tomotherapy (HTT) for LN recurrence.

METHODS: This retrospective study included 68 patients affected by PCa (mean age, 68 y; age range, 51-81 y) with biochemical recurrence after primary treatment (median prostate-specific antigen values obtained at the time of PET/CT scan, 2.42 ng/mL; range, 0.61-27.56 ng/mL) who underwent (11)C-choline PET/CT from January 2005 to January 2013 and were treated with HTT in correspondence of the pathologic choline LN uptake. PET-derived parameters, including maximum/mean standardized uptake value (SUVmax and SUVmean, respectively) and metabolic tumor volume (MTV) with a threshold of 40%, 50%, and 60% were calculated. The best cutoff values of PET-derived parameters discriminating between patients with and without relapse, after treatment guided by PET, were assessed by receiver-operating-characteristic (ROC) curve analysis. Univariate and multivariate Cox regression analysis including the most predictive PET-derived parameters and survival outcomes were performed.

RESULTS: The median follow-up was 20 mo (mean, 26 mo; range, 3-97 mo). (11)C-choline PET/CT showed pathologic LN uptake in 4 patients at the pelvic level, in 5 at the abdominal level, in 13 at both the pelvic and the abdominal level, and in 46 at the abdominal or pelvic or other sites. The 2-y overall survival, locoregional relapse-free survival, cRFS, and bRFS were 87%, 91%, 51%, and 40%, respectively. On the basis of ROC curves, the most discriminative cutoff value for MTV values was an MTV threshold of 60% (MTV60) of greater than 0.64 cm(3). No significant cutoff values were found for SUVmax or SUVmean at univariate analysis, whereas MTV60 was confirmed as an independent predictor in multivariate analysis and significantly correlated with bRFS and cRFS. MTV60 and extrapelvic disease well predict the risk of cRFS.

CONCLUSION: (11)C-choline PET/CT performed as a guide for HTT on LN recurrence is predictive of survival. In particular, MTV60 and extrapelvic disease were the best predictors of tumor response for bRFS and cRFS in PCa patients with LN recurrence after primary treatment. This information may be useful in emerging treatment strategies.

^{11}C-CHO PET/CT指导前列腺癌治疗

Q J Nucl Med Mol Imaging. 2015 Sep;59(3):342-50. Epub 2014 May 21.

11C-Choline PET/CT in the primary diagnosis of prostate cancer: impact on treatment planning.

Garcia JR[1], Jorcano S, Soler M, Linero D, Moragas M, Riera E, Miralbell R, Lomeña F.

Author information

Abstract

AIM: Aim of the present study was to evaluate the usefulness of 11C-choline PET/CT for detecting lymphatic or haematogenous spread and for planning radiotherapy in patients with medium-to-high risk prostate cancer.

METHODS: We have included 61 consecutive patients recently diagnosed with cancer prostate by biopsy. All patients were classified as medium-to-high risk: Gleason: 7-9; PSA: 6.3-30.4 ng/mL; stage T2c (N.=20) or stage T3 (N.=41). Image acquisition began 5 min after intravenous injection of 11C-choline (656+119 MBq), starting at the pelvis and continuing craniocaudally. Images were interpreted visually to evaluate uptake by the prostate gland. Lymph nodes with 11C-choline uptake were considered invaded, regardless of their size. Bone lesions were considered positive when they showed greater focal uptake than the surrounding bone. In patients with evidence of lymph-node invasion or bone metastases (15 patients), disease was classified as locoregional, oligometastatic, or multimetastatic.

RESULTS: All patients had prostate gland uptake (20 focal, 8 bifocal, and 33 multifocal). Extraprostatic disease was present in 15 patients (24.6%), as follows: 9 (60%) in a single location: in an infradiaphragmatic lymph node (N.=6), in a supradiaphragmatic lymph node (N.=1), and in bone (M1) (N.=2). Six (40%) as multifocal invasion: with both infra- and supradiaphragmatic lymph node involvement (N.=2); with infradiaphragmatic lymph node involvement and M1 bone metastases (N.=3); and infra- and supradiaphragmatic lymph node involvement plus M1 bone metastases (N.=1). Disease was classified as locoregional (N.=6), oligometastatic (N.=5), and multimetastatic (N.=4). The 11 (73.3%) patients with locoregional and oligometastatic disease were selected to undergo intensity-modulated radiation therapy with dose escalation based on the PET findings.

CONCLUSION: Our results suggest that 11C-choline PET/CT is a useful one-stop diagnostic procedure for evaluating patients with medium/high risk prostate cancer scheduled for radical treatment. 11C-choline PET/CT can reliably rule out lymph node involvement and remote metastases, allowing to select candidates for radiotherapy and to plan their treatment.

PMID: 24844254

前列腺癌分子影像学新进展

三、PSMA PET/CT

前列腺特异性膜抗原（PSMA）表达与前列腺、唾液腺、小肠及肾，在前列腺癌细胞中过表达。

^{68}Ga-PSMA PET/CT可以准确显示残留病灶部位，以利于提高挽救性治疗准确性。

^{68}Ga-PSMA PET/CT可用于PSA较低（eg. 0.2 ng/ml）的早期复发患者的诊断。

Afshar-Oromieh A et al. The diagnostic value of PET/CT imaging with the (68)Ga-labelled PSMA ligand HBED-CC in the diagnosis of recurrent prostate cancer. Eur J Nucl Med Mol Imaging. 2015;42(2):197−209.

前列腺癌分子影像学新进展

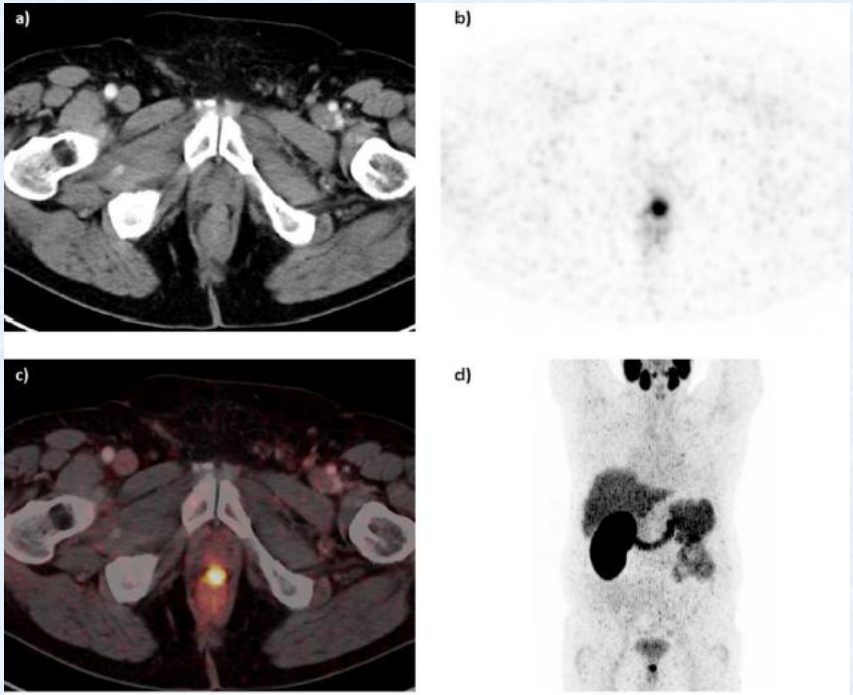


Fig.3 68Ga-HBED-CC-PSMA PET/CT image of a patient with locally recurrent PCa (PSA 3.7 ng/ml) after radical prostatectomy (SUVmax 12.4) who received 140 MBq of the 68Ga-labeled tracer molecule and was scanned at 1 h p.i.; a) CT image, b) PET image, c) PET/CT fusion image, d) MIP.

Lutje S et al. PSMA Ligands for Radionuclide Imaging and Therapy of Prostate Cancer: Clinical Status. Theranostics. 2015 Oct 18;5(12):1388-401

总结

前列腺癌是男性最常见的肿瘤，发病率和死亡率较高。目前，前列腺癌显像对于肿瘤分期、再分期及治疗方法选择方面有重要作用。^{11}C-CHO 和PSMA PET/CT是目前最新的用于Pca的放射核素显像，可以用于早期复发患者的诊断。^{18}F-NaF 及^{18}F-FDG PET/CT可用于检测远处转移。另外，针对肿瘤特异性分子探针技术的研究正在进行，它们可能以基因、生化标志物为基础对未来肿瘤分期提供新的非侵入性方法。

新的分子显像技术能帮助我们进入前列腺癌的精准诊疗时代。

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技术与继续教育学组成员名单

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