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PET 在肾上腺肿瘤中的应用

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【摘要】　随着常规影像学诊断技术在临床上的广泛应用，肾上腺肿瘤的发现越来越多，但常规影像检查难以对所有肾上腺肿瘤做出准确定性诊断。PET是新兴的功能成像手段，对肾上腺良、恶性肿瘤鉴别的准确性高，在临床中的应用日益增多，而且 PET 示踪剂的迅速发展也提高了其临床应用价值。

【关键词】　肾上腺肿瘤；正电子发射断层显像术；氟脱氧葡萄糖 F18

The diagnostic value of PET in adrenal tumors

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【Abstract】　With the comprehensive apply of routine imaging techniques in clinic, more and more adrenal accidental tumors were detected. But routine imaging techniques could not confirm all of the adrenal accidental tumors. PET is a promising functional imaging modality and can differentiate correctly the benign and malignant adrenal tumors. Application of PET in clinic is gradually increased, and the advance of PET tracer improves its value.

【Key words】　Adrenal gland neoplasms; Positron-emission tomography; Fluorodeoxyglucose F18

虽然绝大多数肾上腺肿瘤为无临床症状或生化检查无异常表现的良性皮质腺瘤，但也有少部分为嗜铬细胞瘤、转移瘤或其他非皮质来源的肿瘤，单凭常规检查方法有时难以准确判断其起源及良、恶性。本文综述 PET 对肾上腺肿瘤的诊断价值。

1　18F-FDG PET

1.1　正常肾上腺

由于正常肾上腺摄取 18F-FDG 很少，所以在单

纯 ^{18}F-FDG PET 图像上正常肾上腺很难被确认。PET-CT 出现后，Bagheri 等[11]在 CT 图像解剖定位的基础上对正常肾上腺的 ^{18}F-FDG PET 表现及标准化摄取值(standardized uptake value, SUV)进行了研究，如果在肾上腺部位可见高于邻近本底水平的 ^{18}F-FDG 摄取灶，则认为肾上腺可见，并与肝脏摄取活性比较后进行视觉分级：0 级为不可见，1 级为肾上腺摄取较肝脏低，2 级为肾上腺摄取与肝脏相同，3 级为肾上腺摄取高于肝脏。结果：单独分析 PET 图像，40 个肾上腺中仅 2 个可见，分析 PET-CT 融合图像，则 27 个肾上腺可见；右侧肾上腺的平均 SUV 为 0.83 ± 0.17，左侧肾上腺的平均 SUV 为 0.94 ± 0.15，并与视觉分级呈正相关。综合分析后笔者认为，当 CT 显示肾上腺正常，而 PET 显示肾上腺仅有轻度 ^{18}F-FDG 浓集(等于或略高于肝脏摄取)时，应考虑为肾上腺正常摄取。

1.2 肾上腺病变良、恶性的鉴别

肾上腺肿瘤的发现随着年龄的增长而逐渐增多，准确鉴别其良、恶性具有重要意义。Blake 等[2]对 36 例恶性肿瘤和 2 例可疑肺癌患者的 41 个肾上腺肿瘤病灶行 ^{18}F-FDG PET-CT 发现，以 SUV = 2.86 为临界值，[18]F-FDG PET 诊断恶性肿瘤的灵敏度为 100%、特异度为 78.1%、阳性预测值 = 56.3%、阴性预测值为 100%、准确率为 82.9%；与肝脏 ^{18}F-FDG 摄取活性相比，所有恶性肿瘤的 ^{18}F-FDG 摄取程度均高于肝脏，而无假阴性表现；32 个良性病变中，30 个摄取程度低于肝脏，2 个高于肝脏，特异度为 93.8%。有学者认为，以肿瘤与肝脏 ^{18}F-FDG 摄取比值来判断肾上腺肿块的良恶性较单纯，测定肾上腺肿瘤 SUV 则更加准确[3-4]。Jana 等[5]对 74 例患者的 80 个肾上腺肿块行 ^{18}F-FDG PET 和 CT 的对比研究发现，[18]F-FDG PET 对转移瘤的诊断灵敏度和特异度分别为 93% 和 96%，对 CT 难以定性肿块的诊断灵敏度和特异度分别为 88% 和 96%。由此可见，[18]F-FDG PET 可对肾上腺肿块进行准确定性，特别是在 CT 难以定性的肿瘤患者的肾上腺肿块具有重要价值，与延迟对比增强 CT 相结合，可提高其特异度到 100%。Metser 等[6]对 150 例患者的 175 个肾上腺肿块行 ^{18}F-FDG PET-CT 发现，以 SUV = 3.1 为界，单独 PET 诊断肾上腺肿块良、恶性的灵敏度、特异度、阳性预测值和阴性预测值分别为 98.5%、92%、89.3% 和 98.9%，结合 CT 图像后分

别提高到 100%、98%、97% 和 100%，由此可见，PET-CT 的诊断准确性更高[7]。

肾上腺病变 ^{18}F-FDG PET 最常见的假阴性原因为病变体积小、坏死性转移瘤和神经内分泌肿瘤转移等[8]。假阳性摄取的常见原因有良性嗜铬细胞瘤、腺瘤和增生等[9-11]，其他少见的假阳性肾上腺病变有结核、组织胞浆菌病、嗜酸细胞腺瘤、神经节细胞瘤等[12-13]。当 PET 可见双侧肾上腺明显摄取 ^{18}F-FDG，而其他部位未见原发肿瘤征象时，应考虑到良性病变的可能。

2 肾上腺皮质肿瘤显像

依托咪酯(etomidate, ETO)是一种肾上腺皮质合成皮质醇和醛固酮的关键酶抑制剂，它主要通过抑制细胞色素 P450 连接的 11β-羟化酶系统来阻断 11-去氧皮质醇向皮质醇和 11-去氧肾上腺酮向肾上腺酮的转化。美托咪酯(metomidate, MTO)是 ETO 的甲基类似物，与 ETO 有相同的作用。Hennings 等[14]对 75 例肾上腺病变患者的 ^{11}C-MTO PET 结果进行回顾性分析，75 例中皮质腺瘤 26 例、皮质癌 13 例、皮质增生 8 例、嗜铬细胞瘤 6 例、转移瘤 3 例、非皮质来源肿瘤 19 例，均经手术或活检病理证实。结果，47 例肾上腺皮质来源病变中 42 例可见 ^{11}C-MTO 摄取(灵敏度为 89%)，1 例为假阳性(特异度为 96%)，5 例为假阴性(其中 2 例手术病理证实为几乎完全坏死的肾上腺皮质癌，2 例为直径 <1cm 的 Conn 腺瘤，1 例为直径约 1cm 的结节样增生)，嗜铬细胞瘤、转移瘤和良性非肾上腺皮质来源肿瘤均未见 ^{11}C-MTO 摄取；当病变灶 SUV>24.3 时有 95%可能为肾上腺皮质癌或皮质腺瘤，当 SUV>32 时有 95%的可能为 Conn 腺瘤，当病变与对侧肾上腺 SUV 的比值 >1.4 时，有 99.5%可能为肾上腺皮质肿瘤。[18]F-FDG PET 虽然能准确判断病变的良、恶性，但难以确定其组织来源，而对少数常规影像学检查难以定性的肾上腺肿瘤，[11]C-MTO PET 是有价值的补充检查手段[15-17]。

Wadsak 等[18]用 [18]F 标记的 ETO 类似物 ^{18}F-FETO 对鼠模型研究发现，[18]F-FETO 在肾上腺摄取最高，注药后 30 min 达到峰值，60 min 时轻度下降，其余依次为肺、肝和肾，而且其与 11β-羟化酶的亲和力较 ^{11}C-MTO 更高。对健康志愿者的研究也显示，[18]F-FETO 在肾上腺可见明显摄取，肝脏、肾盂、胆囊、

胃壁和胰腺可见中等程度摄取，在注药后 3 min，肾上腺即可摄取 ^{18}F-FETO，此后摄取程度逐渐增高，注药后 12~15 min 采集的图像可满足临床诊断的需要。笔者认为，[18]F-FETO 是有价值的肾上腺皮质 PET 显像剂[18]。

3　肾上腺髓质肿瘤 PET

嗜铬细胞瘤约 90% 表现为单发肾上腺良性髓质肿瘤，目前对其诊断主要依靠血浆和尿液中儿茶酚胺及其代谢产物的测定，定位则主要依靠 CT、MRI 等。虽然嗜铬细胞瘤对 ^{18}F-FDG 的摄取程度高，但是良、恶性肿瘤的 SUV 没有区别，而且 ^{18}F-FDG 摄取程度与肿瘤激素分泌状态无相关性，[18]F-FDG PET 不是检出嗜铬细胞瘤的最佳方法[19]。

羟基麻黄素（hydroxyephedrine, HED）是儿茶酚胺类似剂，在交感神经分布丰富的区域呈选择性浓集，如心脏和肾上腺髓质，HED 水平反映了儿茶酚胺的转运、贮存和神经元的再摄取。Mann 等[20]对 14 例可疑嗜铬细胞瘤患者行 ^{11}C-HED 与 ^{18}F-FDG PET 研究发现，所有确诊嗜铬细胞瘤患者用 ^{11}C-HED PET 均可检出全部病灶，而 ^{18}F-FDG PET 未能检出骨转移灶，因此认为，[11]C-HED PET 是检出嗜铬细胞瘤的首选功能性检查方法。

嗜铬细胞瘤属神经内分泌肿瘤，可对氨基酸进行摄取、脱羧和贮存。Brink 等[21]利用这一特性对嗜铬细胞瘤行 [18]F-左旋多巴 PET，结果：14 例患者共检出嗜铬细胞瘤灶 17 个，均为良性，其中 9 个经手术病理证实，而正常对照组肾上腺无生理性摄取，因此认为，[18]F-左旋多巴 PET 是检出嗜铬细胞瘤高敏感度、高特异度的功能性显像方法。Imani 等[22]对 25 例已知或可疑嗜铬细胞瘤患者行 [18]F-左旋多巴 PET 和 PET-CT 的结果显示，其灵敏度为 84.6%、特异度为 100%、准确率为 92%，其中 3 例恶性嗜铬细胞瘤患者均发现了转移灶，2 例患者表现为假阴性，未发现假阳性。此外，[18]F-左旋多巴 PET 的优势还在于不需要中断服用儿茶酚胺类药物的治疗，而且对儿茶酚胺检测难以确诊的患者可做出明确诊断或排除诊断，是高度敏感和特异的检查方法，不仅可提高检出率，而且可提高定位准确性[23]。研究表明，[18]F-左旋多巴与 ^{18}F-FDG PET 结合，对腹部和恶性嗜铬细胞瘤可提供常规影像学无法提供的信息[24]。

[18]F- 氟多巴胺是多巴胺的类似物，[18]F-氟多巴胺 PET 与 CT 或 MRI 结合可对嗜铬细胞瘤准确定位。当化验支持嗜铬细胞瘤的诊断、但常规影像学检查为阴性时，应行 [18]F-氟多巴胺 PET 以明确诊断。Timmers 等[25]的研究也显示，虽然正常肾上腺可摄取 [18]F-氟多巴胺，但嗜铬细胞瘤的摄取程度更高，[18]F-氟多巴胺 PET 诊断嗜铬细胞瘤的灵敏度和特异度均为 100%。

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