

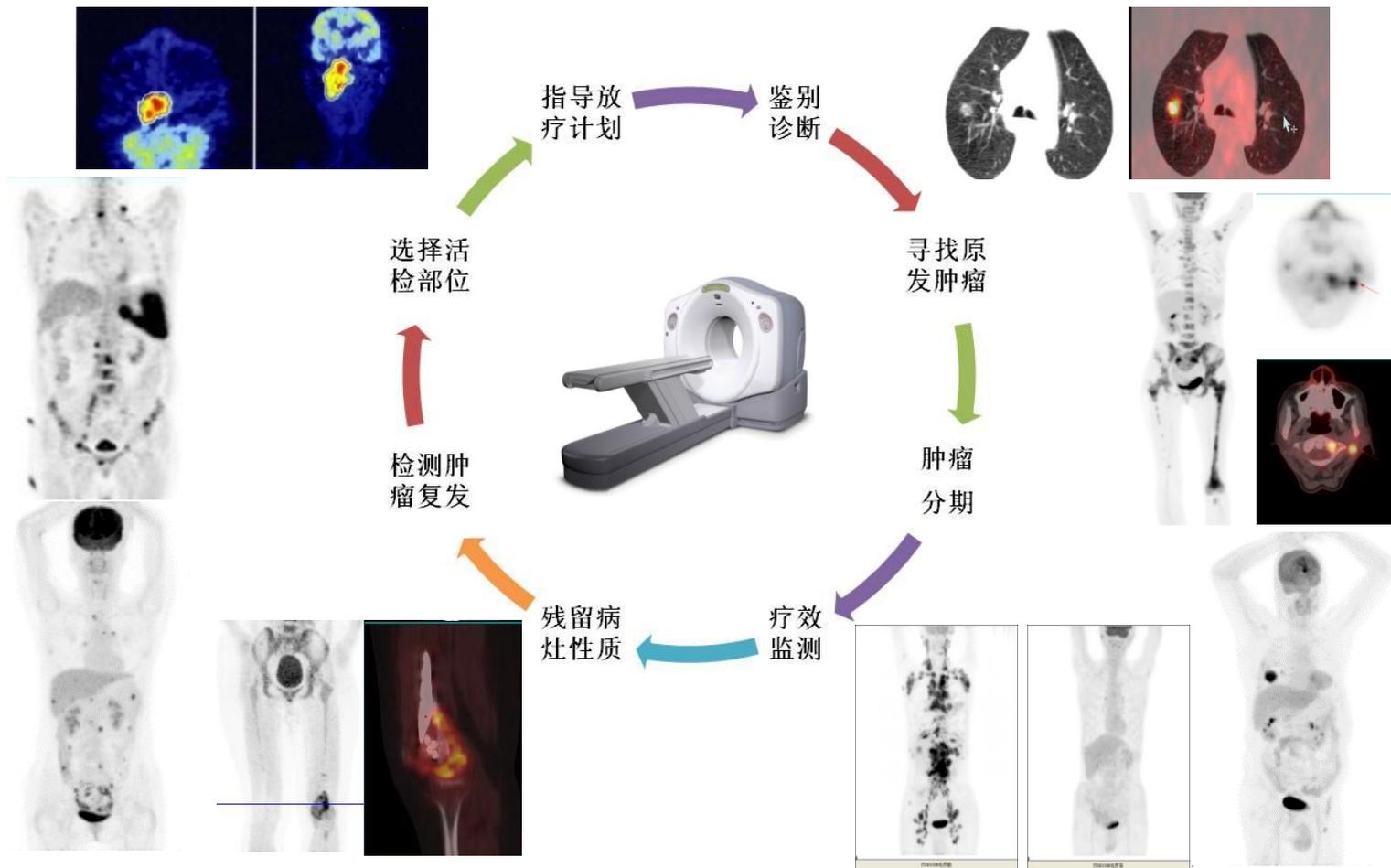
FDG PET/CT

感染与炎症的诊断应用

北京大学人民医院 核医学科 王茜

2019.9.19昆明

FDG PET/CT肿瘤学应用



感染与炎症

炎症 (*Inflammation*)

- 指机体具有血管系统的活体组织对损伤因子所发生的防御反应
- 基本病理改变：局部组织变性、渗出和增生
- 临床表现：局部红、肿、热、痛和功能障碍，并可伴有发热、白细胞增多、单核-巨噬细胞系统增生及血清炎性因子增高等全身反应。

感染 (*Infection*)

- 特指由生物因子侵入人体所引起的炎症反应
- 感染的治疗需根据不同的病原体采取相应的抗生素或抗病毒药物

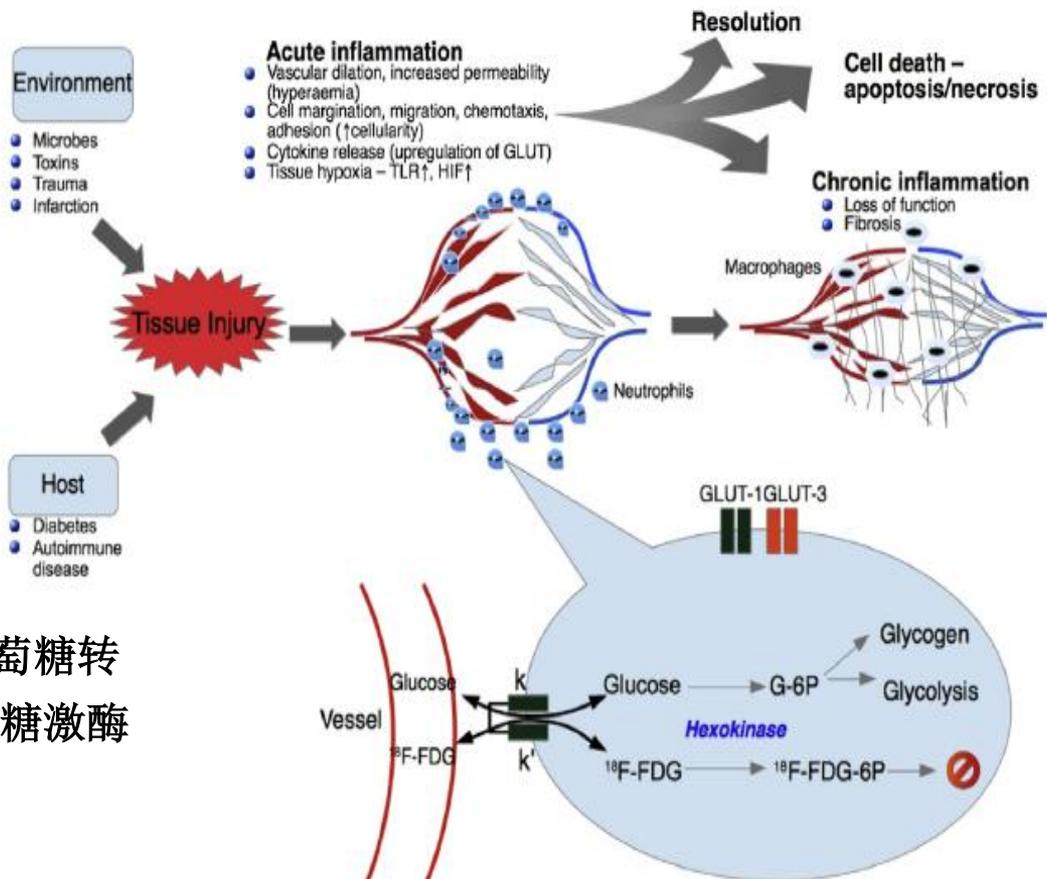
非感染性炎症

(*Noninfectious inflammation*)

- 多为自身免疫相关性疾病。
- 治疗以抗炎药、糖皮质激素抑制过于强烈的炎症反应，减轻症状，防止功能障碍等不良反应事件的发生

FDG PET/CT 炎症显像

- Warburg提出恶性肿瘤细胞通过非氧化性葡萄糖分解比正常细胞产生更多的能量。
- Kubota观察到FDG被肿瘤摄取的一个重要组成部分是活跃于肿瘤周围的炎性细胞。



中性粒细胞和单核/巨噬细胞的葡萄糖转运体**GLUT1**和**GLUT3**呈高表达，糖激酶活性很高，可摄取更多**FDG**。

FDG PET/CT感染与炎症临床应用适应证

- 1) 结节病
 - 2) 外周骨髓炎(非术后、非糖尿病足)
 - 3) 怀疑脊柱感染(脊柱炎或椎体骨髓炎，非术后)
不明原因发热(FUO)的评估，包括符合Durack标准或Street标准的FUO、术后发热和复发性脓毒症、
 - 4) 免疫缺陷(诱导和获得性)相关的FUO、中性粒细胞减少症发热以及单纯急性炎症标志物(CRP和ESR)的持续升高。
 - 5) 转移性感染和菌血症高危患者的评估
 - 6) 医疗植入体相关感染的检出（如关节假体置换术后、心脏起搏器植入术后、人工血管植入术后）
 - 7) 多囊性疾病中可能存在的肝囊肿和肾囊肿感染
 - 8) 艾滋病相关机会性感染、肿瘤和Castleman病
 - 9) 肺结核病变活动性评估
 - 10) 多种风湿免疫病的鉴别诊断及病变活动性评估（如RA、成人still病、系统性血管炎、IIM、SLE、风湿性多肌痛、复发性多软骨炎等）
-

不明原因发热 (fever of unknown origin, FUO)

临床诊断流程

- 病程超过三周
- 体温 $\geq 38.3^{\circ}\text{C}$ ，三次以上
- \geq 三次门诊/三天住院不能明确诊断



询问病史



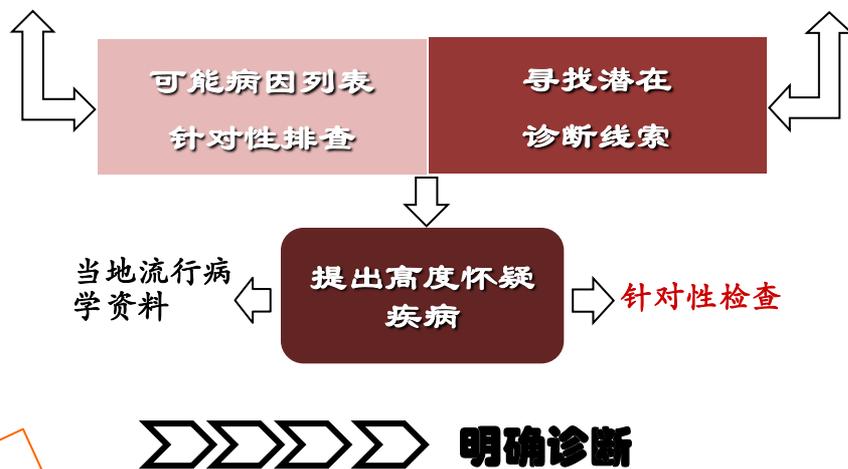
体格检查



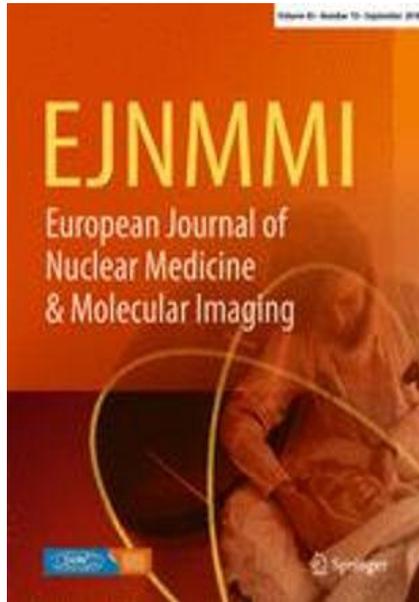
实验室检查



影像检查



FDG PET/CT用于FUO/IUO多中心研究



European Journal of Nuclear Medicine and Molecular Imaging (2019) 46:159–165

<https://doi.org/10.1007/s00259-018-4121-1>

ORIGINAL ARTICLE



^{18}F -FDGPET/CT in fever of unknown origin and inflammation of unknown origin: a Chinese multi-center study

Qian Wang¹ · Ya-Ming Li² · Yuan Li¹ · Feng-Chun Hua³ · Quan-Shi Wang⁴ · Xiao-Li Zhang⁵ · Chao Cheng⁶ · Hua Wu⁷ · Zhi-Ming Yao⁸ · Wei-Fang Zhang⁹ · Qing-Yi Hou¹⁰ · Wei-Bing Miao¹¹ · Xue-Mei Wang¹²

Received: 3 April 2018 / Accepted: 1 August 2018 / Published online: 11 August 2018

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Abstract

Purpose To evaluate the clinical value of ^{18}F -FDG-PET/CT for the diagnosis of fever of unknown origin (FUO) and inflammation of unknown origin (IUO) in Chinese population, as well as the characteristics of PET/CT in different category of etiological disease.

Methods A total of 376 consecutive patients with FUO/IUO who underwent FDG-PET/CT at 12 hospitals were retrospectively studied. FDG uptake was quantitatively and visually evaluated, by using SUV_{max} and a 4-grade scale respectively. A questionnaire survey to the clinicians was used to evaluate the significance of PET/CT in diagnosing of FUO/IUO. Data analysis included the etiological distribution in the study population, image characteristics in different category of diseases, and clinical significance of PET/CT.

Results In 376 studied patients, the infectious diseases accounted for 33.0% of patients, rheumatologic diseases for 32.4%, malignancies for 19.1%, miscellaneous causes for 6.6%, and cause unknown for 8.8%. However, the etiological distribution among hospitals was varied. In addition, the etiological disease composition ratio has changed over time in China. On PET/CT examinations, 358 (95.2%) of the patients had a positive finding. Within them, local high uptake lesion was found in 219 cases, and nonspecific abnormal uptake (NAU) was found in 187 cases. FDG uptake in malignant diseases was significantly higher than in other category diseases both on SUV_{max} and visual scores (t -value range from 4.098 to 5.612, all P value < 0.001). Based on a clinical questionnaire survey, PET/CT provided additional diagnostic information for 77.4% of patients, and 89.6% of patients benefited from PET/CT examination.

Table 1 Clinical diagnosis and etiological classification in 376 patients with FUO/IUO

Etiology classification	Case number	Proportion	Clinical diagnosis
Infection	124	33.0%	Pathogen: tubercle bacillus (19), Epstein–Barr virus (14), bacterium burgeri (8), Burkholderia cepacia (2), Salmonella gallinarum (1), spirochaeta (1), Penicillium Marneffeii (1), Escherichia coli (1), Klebsiella pneumoniae (1), mycoplasma pneumoniae (1), uncertain (75) Infection site: lung (31), urinary tract (11), periprosthesi (7), lymphnode (4), peritoneum (3), bone (2), intestinal tract (2), ovary or uterus (2), pericardiac (1), liver (1), muscle (1), spleen (1), kidney (1), meninges (1), epididymis (1), multiple sites (17), uncertain (38)
Rheumatologic disease	122	32.4%	Adult-onset Still’s disease (39), undifferentiated connective tissue disease (19), systemic vasculitis (16), idiopathic inflammatory myopathy (10), systemic lupus erythematosus (9), polymyalgia rheumatic (7), relapsing polychondritis (4), rheumatoid arthritis (3), Sjogren's syndrome (3), panniculitis (3), juvenile idiopathic arthritis (3), IgG4-related disease (2), reactive arthritis (2), ankylosing spondylitis (1), antiphospholipid syndrome (1)
Malignancy	72	19.1%	Lymphoma (56), leukemia (9), lung cancer (2), myelodysplastic syndrome (2), colon cancer (1), gastric cancer (1), hepatic cellular cancer (1)
Miscellaneous	25	6.6%	Drug allergy (11), histiocytic necrotizing lymphadenitis (4), Castleman disease (3), primary hemophagocytic syndrome (2), inflammatory bowel disease (2), Rosai–Dorfman disease (1), limbic encephalitis (1), hyperthyroidism (1)
Unknown	33	8.8%	Uncertain (33)

Table 2. Distribution of etiological diseases in different hospitals

	Cases provided	Infection	Rheumatologic disease	Malignancy	Miscellaneous	Unknown
Peking University People's Hospital	170	47 (27.6%)	78 (45.9%)	22 (12.9%)	14 (8.2%)	9 (5.3%)
Huashan Hospital	38	17 (44.7%)	12 (31.6%)	4 (10.5%)	3 (7.9%)	2 (5.3%)
Nanfang Hospital	38	9 (23.7%)	10 (26.3%)	14 (36.8%)	4 (10.5%)	1 (2.6%)
Beijing Anzhen Hospital	25	23 (92.0%)	0 (0.0%)	1 (4.0%)	0 (0.0%)	1 (4.0%)
The First Hospital of China Medical University	20	5 (25.0%)	6 (30.0%)	4 (20.0%)	1 (5.0%)	4 (20.0%)
Other hospitals	85	23 (27.1%)	16 (18.8%)	27 (31.8%)	3 (3.5%)	16 (18.8%)
Total	376	124	122	72	25	33

PET/CT检查结果

- 358 / 376 (95.2%) 例的患者PET/CT有阳性发现

FDG uptake in different category diseases

FDG uptake		Infection	Rheumatologic disease	Malignancy	Miscellaneous	Unknown
SUV _{max}	Mean ± SD	5.4 ± 3.6	4.5 ± 3.0	9.4 ± 7.0	5.0 ± 3.3	4.3 ± 2.6
	Range	0.5 ~ 18.9	1.3 ~ 27.1	2.8 ~ 47.3	1.3 ~ 13.0	1.2 ~ 11.2
Visual score	Mean ± SD	2.3 ± 0.7	2.3 ± 0.5	2.8 ± 0.4	2.4 ± 0.8	2.1 ± 0.7
	Range	0 ~ 3	0 ~ 3	1 ~ 3	0 ~ 3	0 ~ 3

- 恶性肿瘤FDG摄取高于其他种类疾病 (P均<0.001)

- 98.9%的患者可获得病理学检查结果：165例PET/CT检查前获得；242例PET/CT检查后获得，其中可明确诊断者占43.4%。

淋巴结活检 (217例)

- ✦ 确诊50例（23%）：淋巴瘤42，坏死淋巴腺炎4，Castlman病2，罗赛-多夫曼病1和肺癌1
- ✦ 反应性增生118例（54%）：感染性疾病31；风湿病69；恶性肿瘤3；其他混杂项类6；病因不明9
- ✦ 无诊断意义49例

骨髓活检 (169例)

- ✦ 确诊27例（16%）：淋巴瘤16，白血病9，骨髓增生综合征2
- ✦ 不确定46例：骨髓异常增生、嗜血或不确定的异常细胞（感染15；结缔组织病11；恶性肿瘤12；其他3；病因不明5）
- ✦ 无诊断意义96例

- 临床评价： **89.6%**患者受益于PET/CT

Table 5. Impact of FDG PET/CT for the clinical decision in FUO/IUO

Category	G0	G1	G2	G3	Total
Infection	2 (1.6%)	20 (16.1%)	80 (64.5%)	22 (17.7%)	124
Rheumatologic disease	2 (1.6%)	4 (3.3%)	96 (76.9%)	20 (16.4%)	122
Malignancy	3 (4.2%)	1 (1.4%)	35 (48.6%)	33 (45.8%)	72
Miscellaneous	0	4 (16.0%)	16 (64.0%)	5 (20.0%)	25
Unknown	1 (3.0%)	2 (6.1%)	28 (84.8%)	2 (6.1%)	33
Total	8 (2.1%)	31 (8.2%)	255 (67.8%)	82 (21.8%)	376

G0: 误诊或造成困惑

G1: 没有影响

G2: 未改变诊疗决策但增强了决策信心

G3: 改变了诊疗决策

FUO患者中的恶性肿瘤



淋巴瘤



白血病



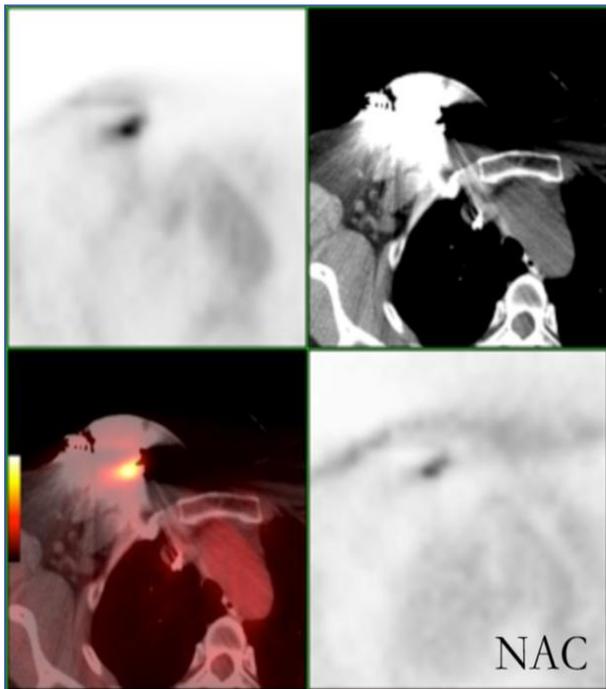
多发性骨髓瘤



转移瘤

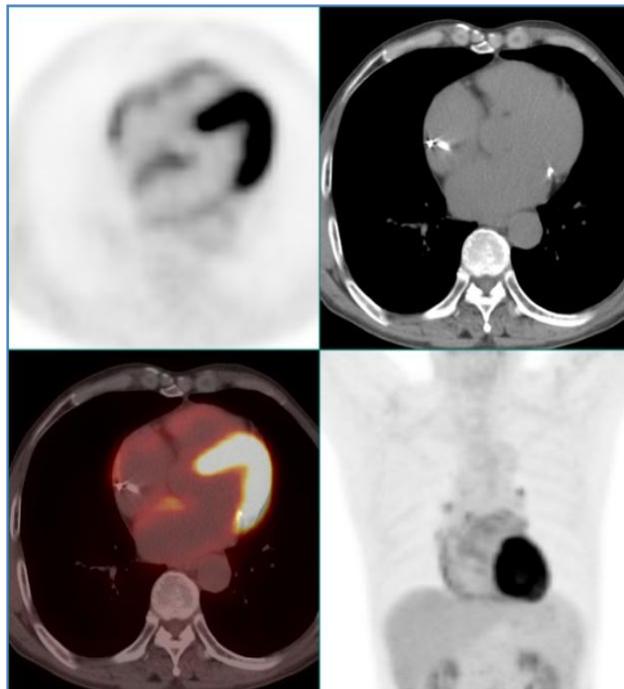
FUO患者中的感染性疾病

■ 医疗植入体相关感染

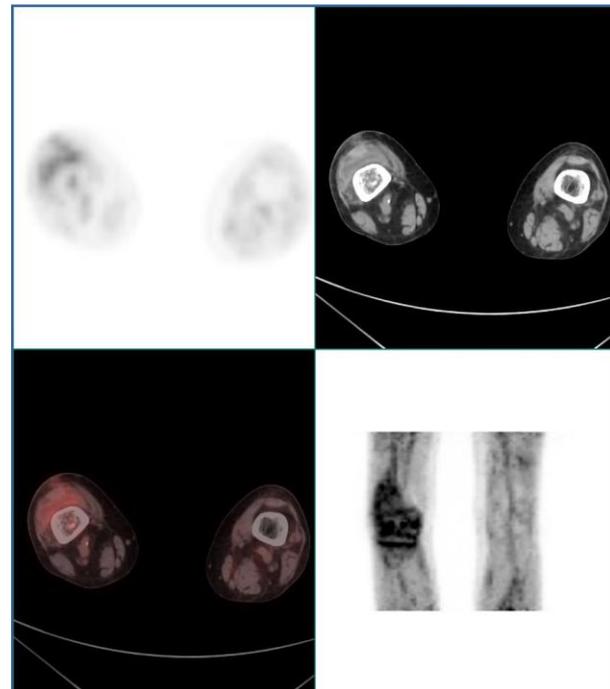


起搏器植入术后囊袋深层感染

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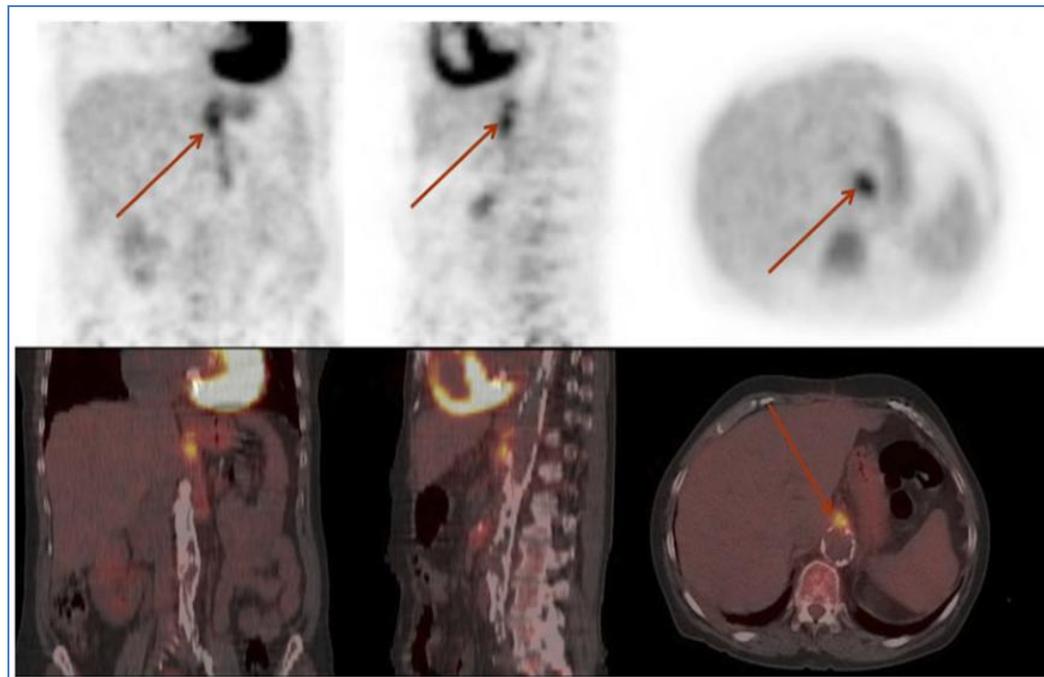


感染性心内膜炎



关节置换术后感染

■ 医疗植入体相关感染



腹主动脉血管支架植入后

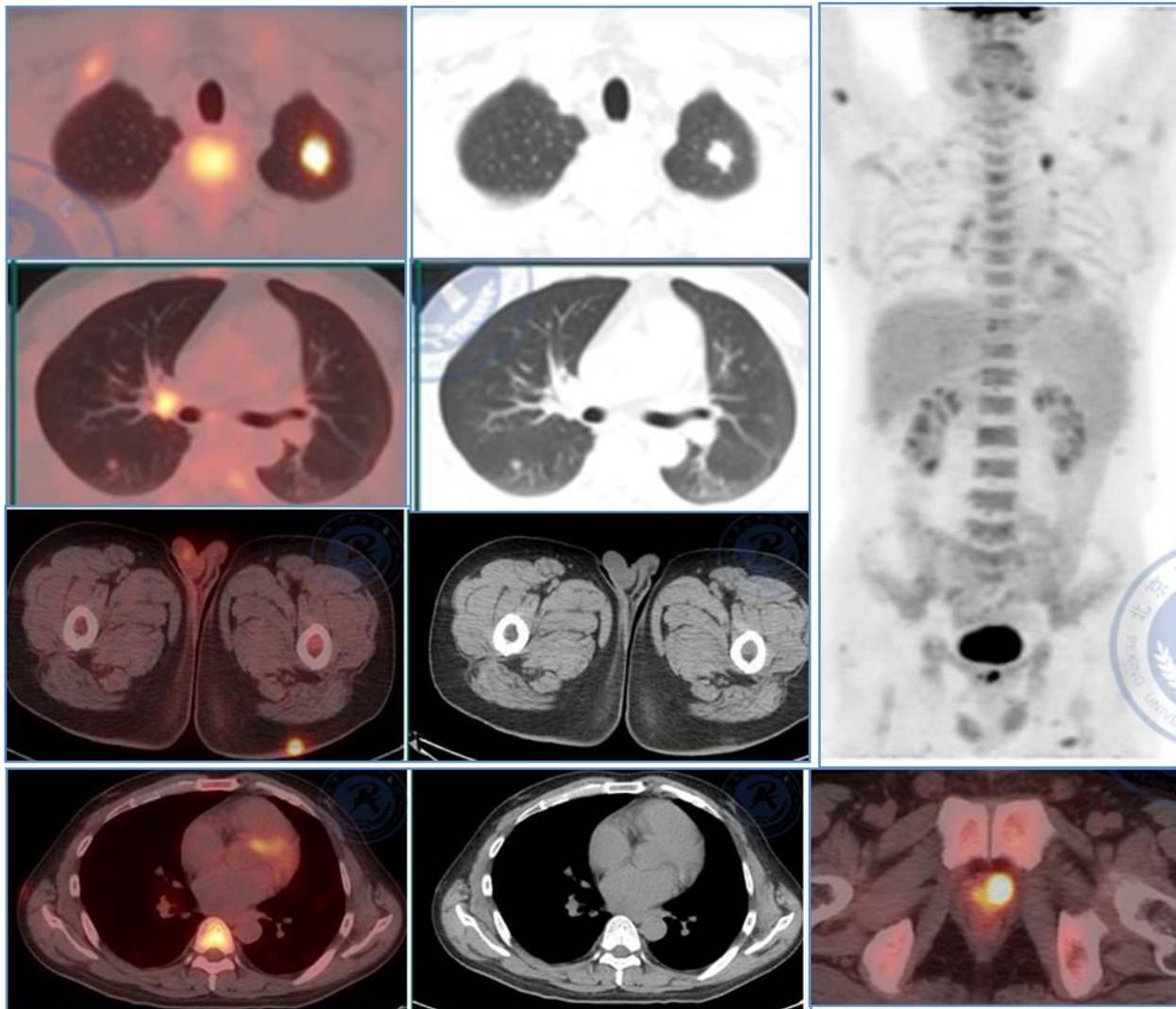


PICC置管后

■布氏杆菌病

➤临床以长期发热（波状热）、乏力、多汗、肌肉和关节疼痛、肝脾及淋巴结肿大为特点。

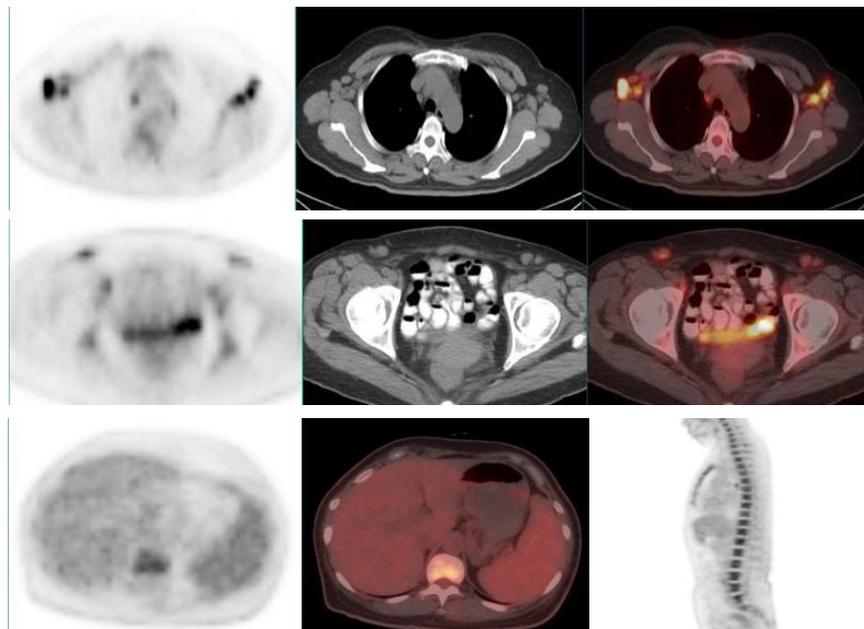
➤病变可累及骨关节、肺及胸膜、生殖器炎、皮肤出等。



FUO患者中的结缔组织病

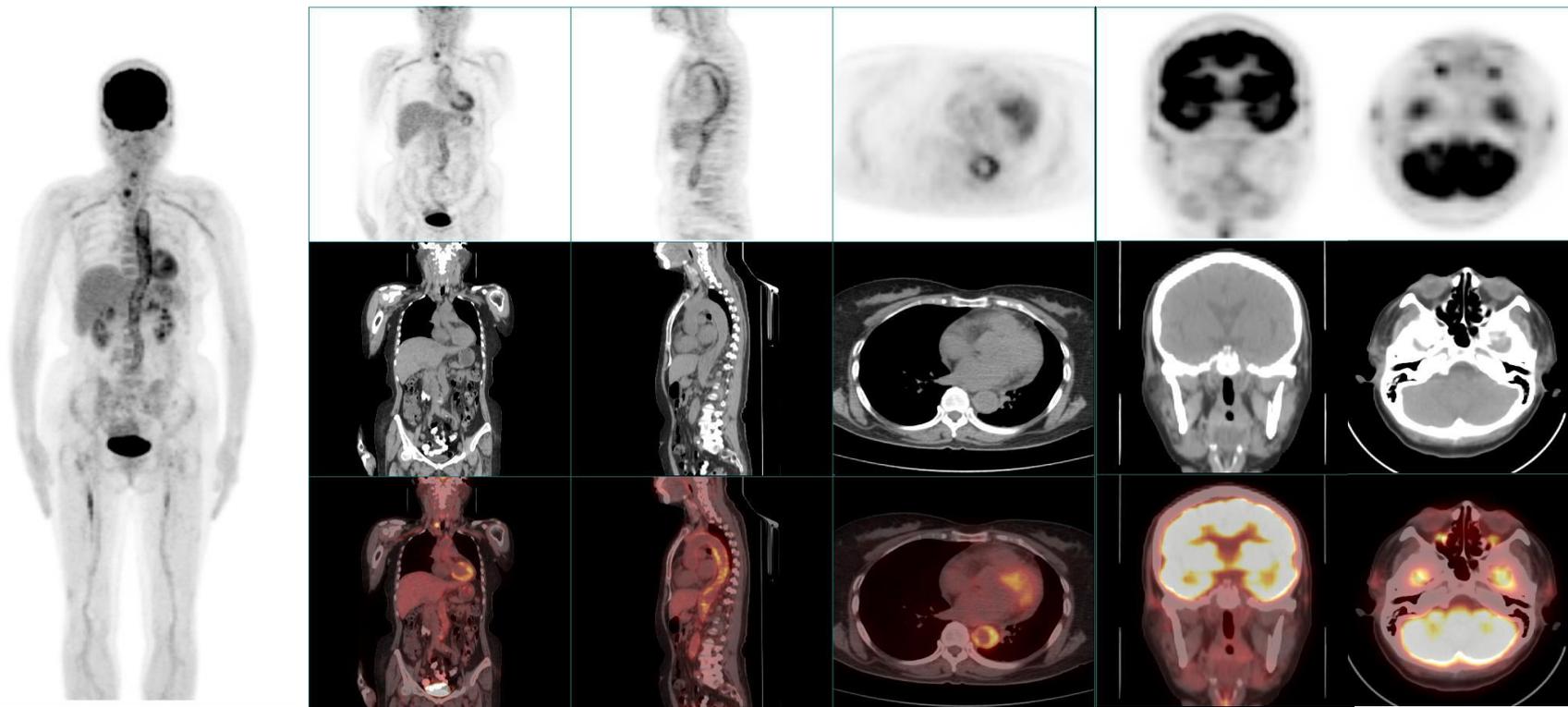
■ 成人still病

(*Adult Onset Still Disease, AOSD*)



■ 系统性血管炎

巨细胞性动脉炎



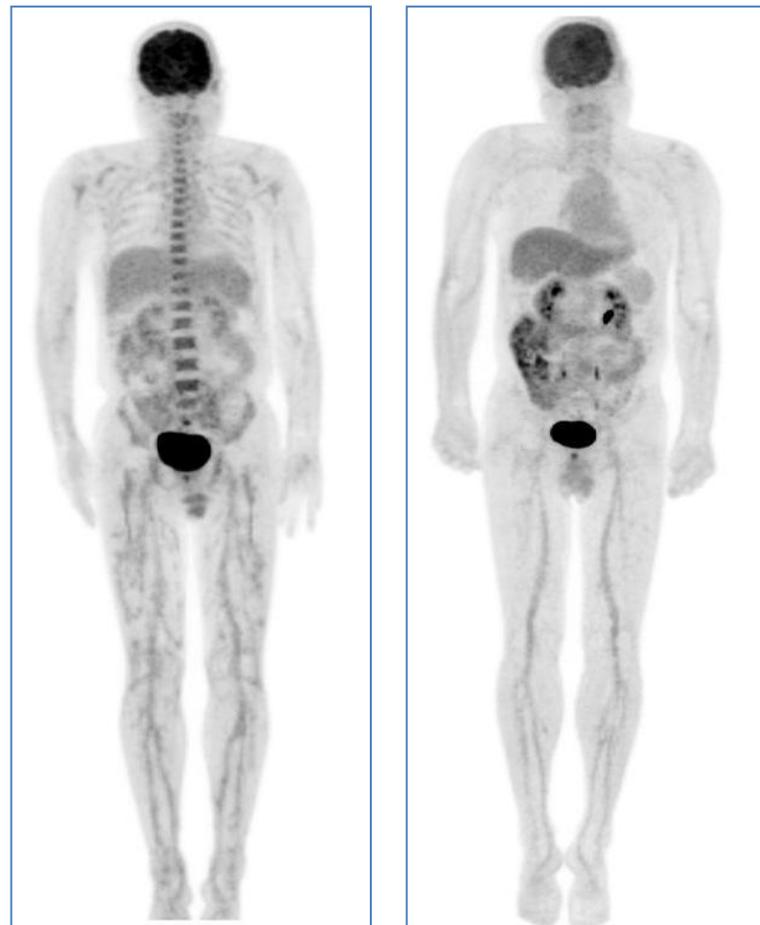
70岁女性，发热伴头痛3周入院。查体发现颈静脉怒张，双颊轻度肿胀，咀嚼力减低。
ESR:104mm/h,CRP:116.64mg/L。



大动脉炎

治疗前

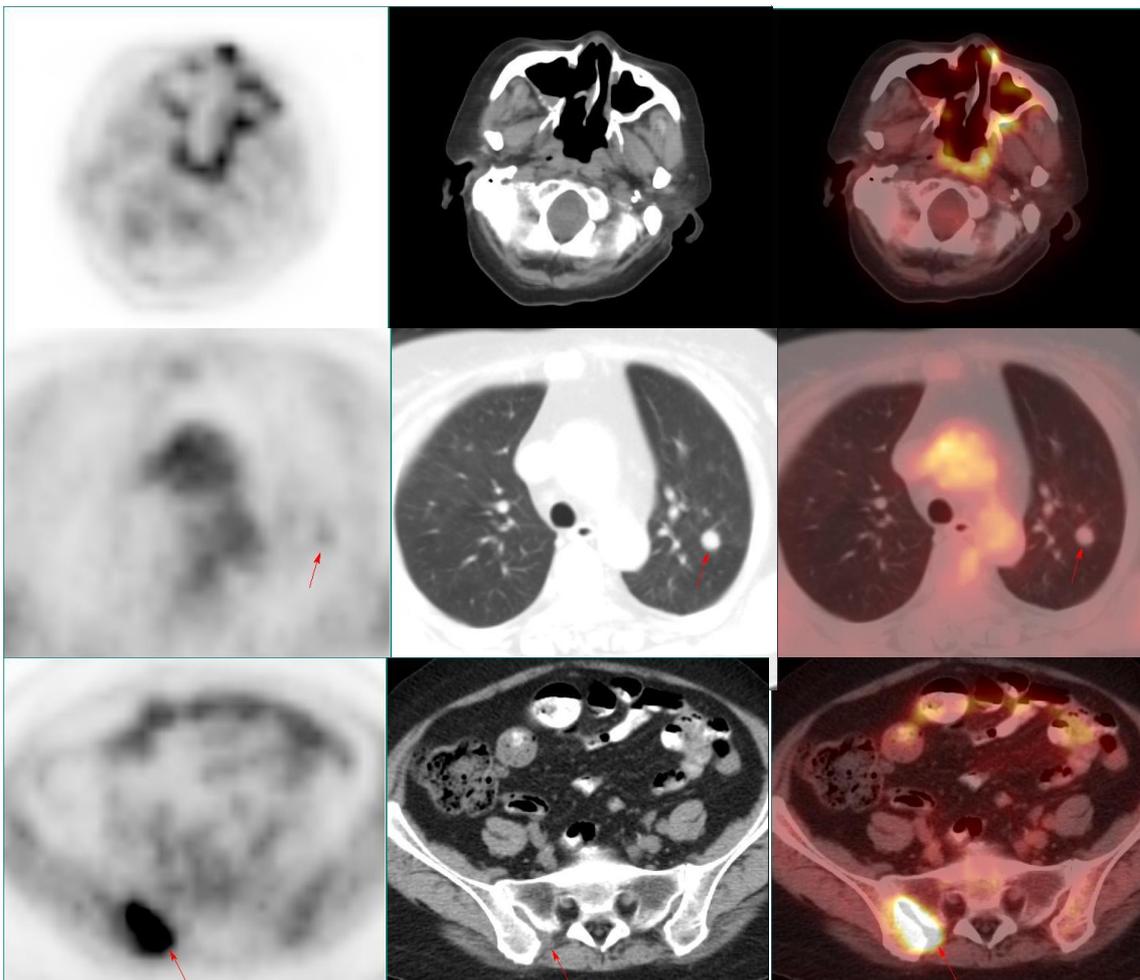
治疗后



结节性动脉炎

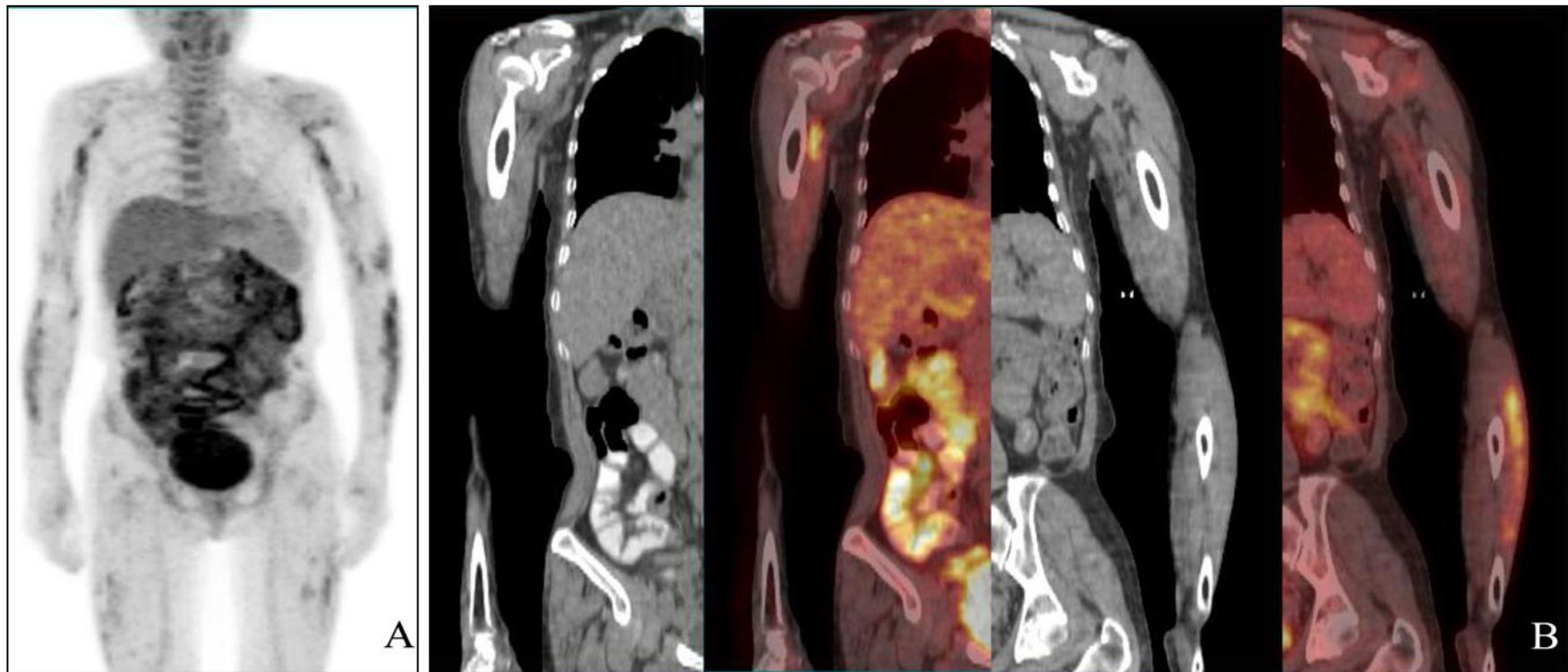


ANCA相关性小血管炎



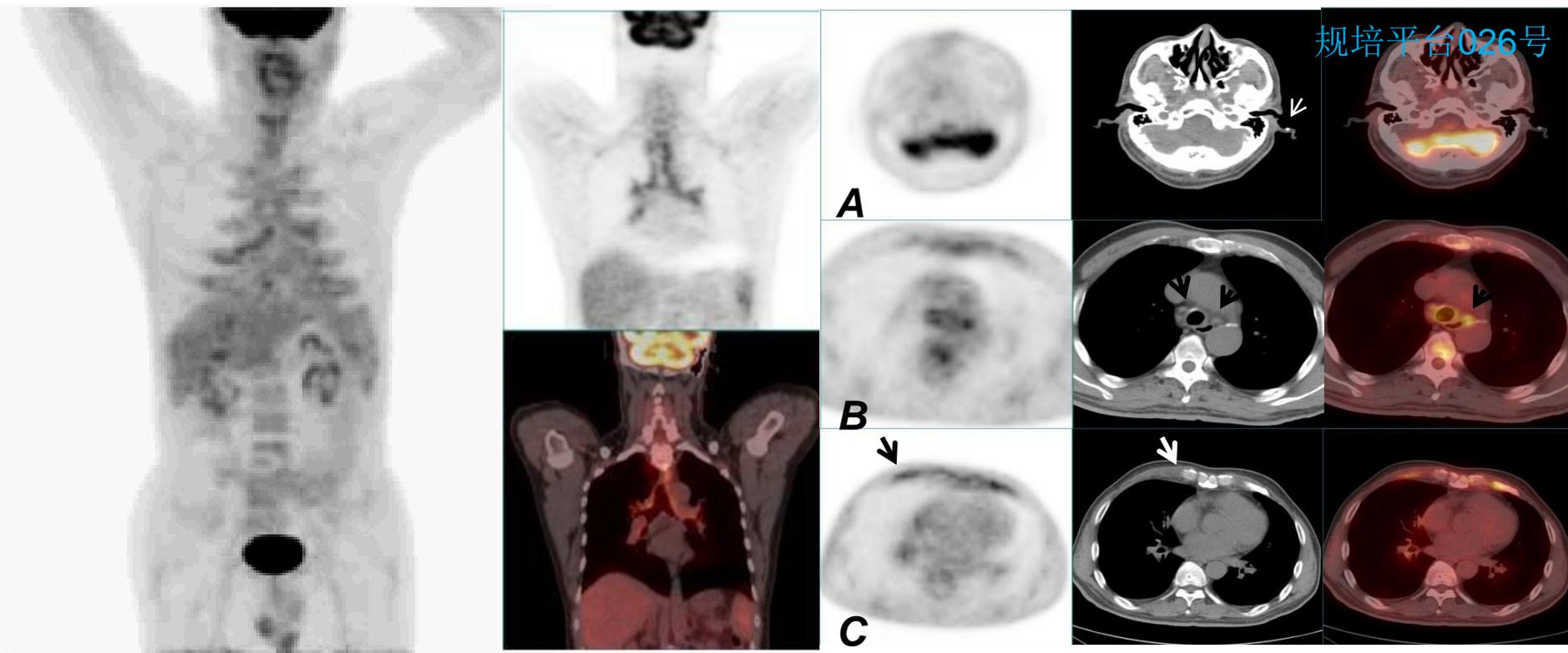
韦格纳肉芽肿

■ 特发性炎性肌病 (*idiopathic inflammatory myopathies, IIM*)



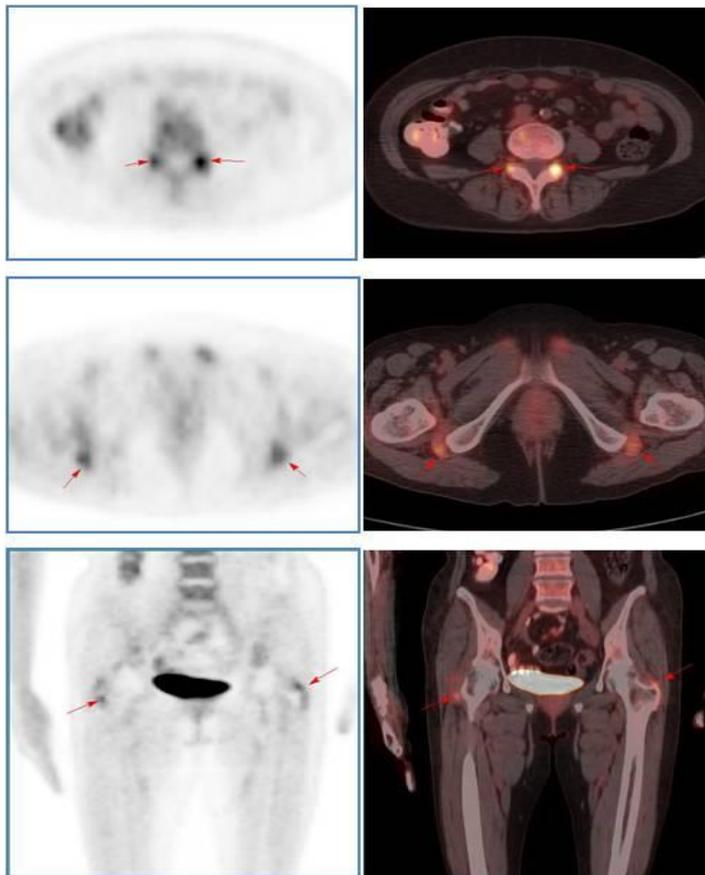
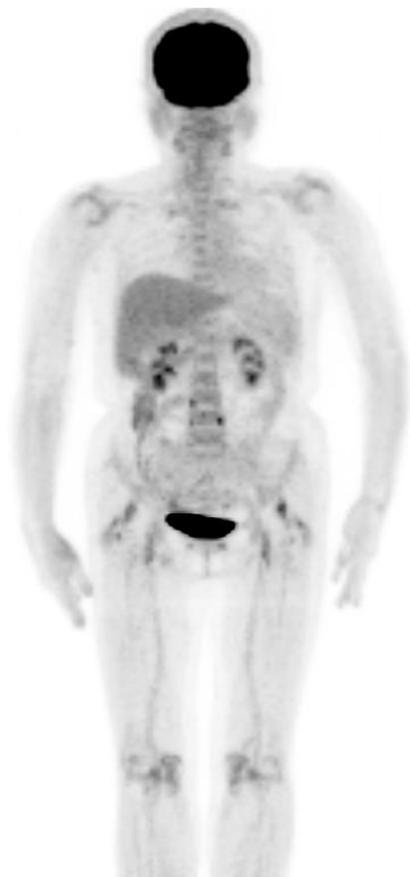
- 肌肉FDG摄取与血清CK水平呈正相关，与肌力水平呈负相关

■ 复发性多软骨炎 (*relapsing polychondritis*)



63岁男性。2月前无明显诱因出现发热伴全身肌肉疼痛，行抗感染治疗和试验性抗痨治疗症状无明显缓解，且疼痛逐渐加重。

风湿性多肌痛 (*polymyalgia rheumatica, PMR*)

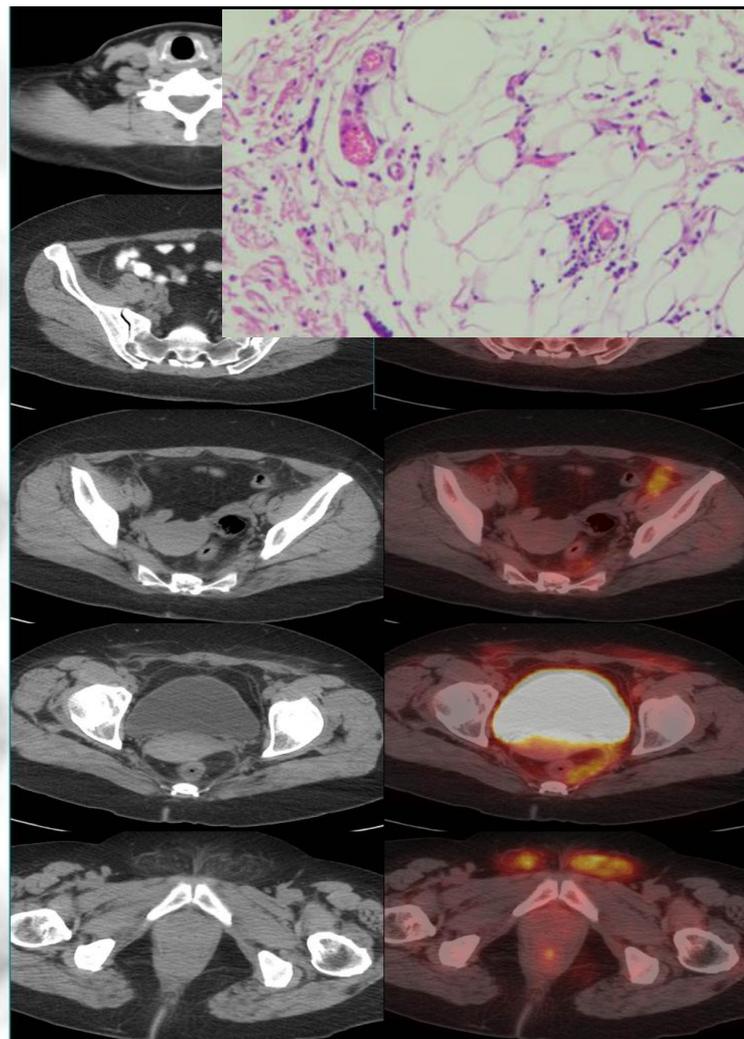
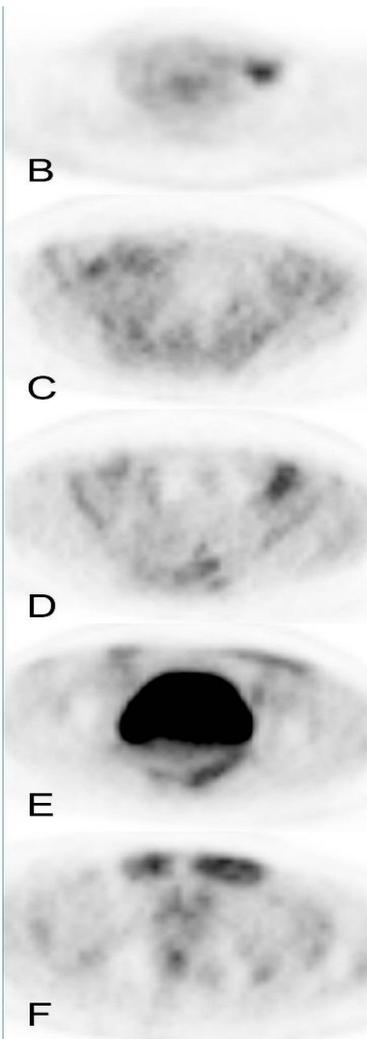


- 老年人不明原因发热伴颈、肩、髋部肌肉疼痛；轻中度贫血，ESR/CRP、白细胞介素 IL-6 升高
- 肌电图和肌活检无炎性肌病依据
- B超、MRI可见关节滑膜炎
- 自身抗体及类风湿因子阴性

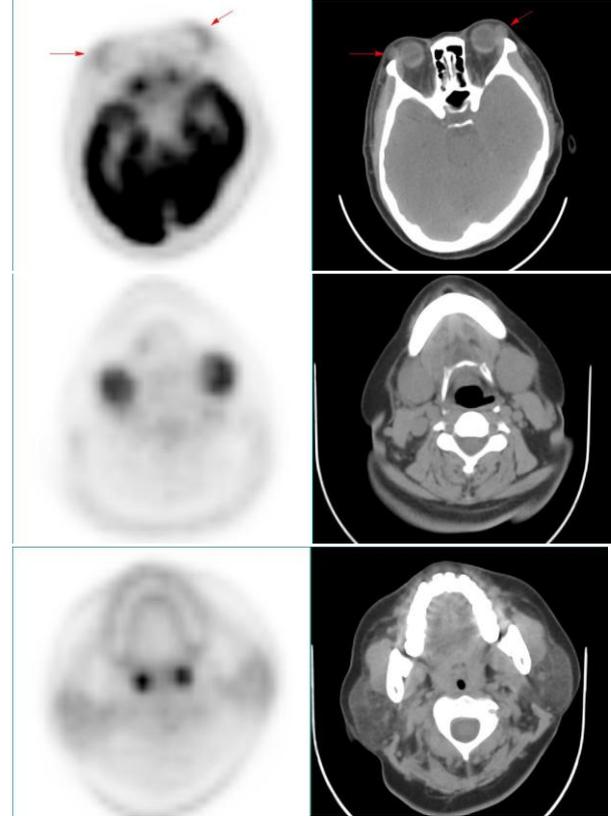
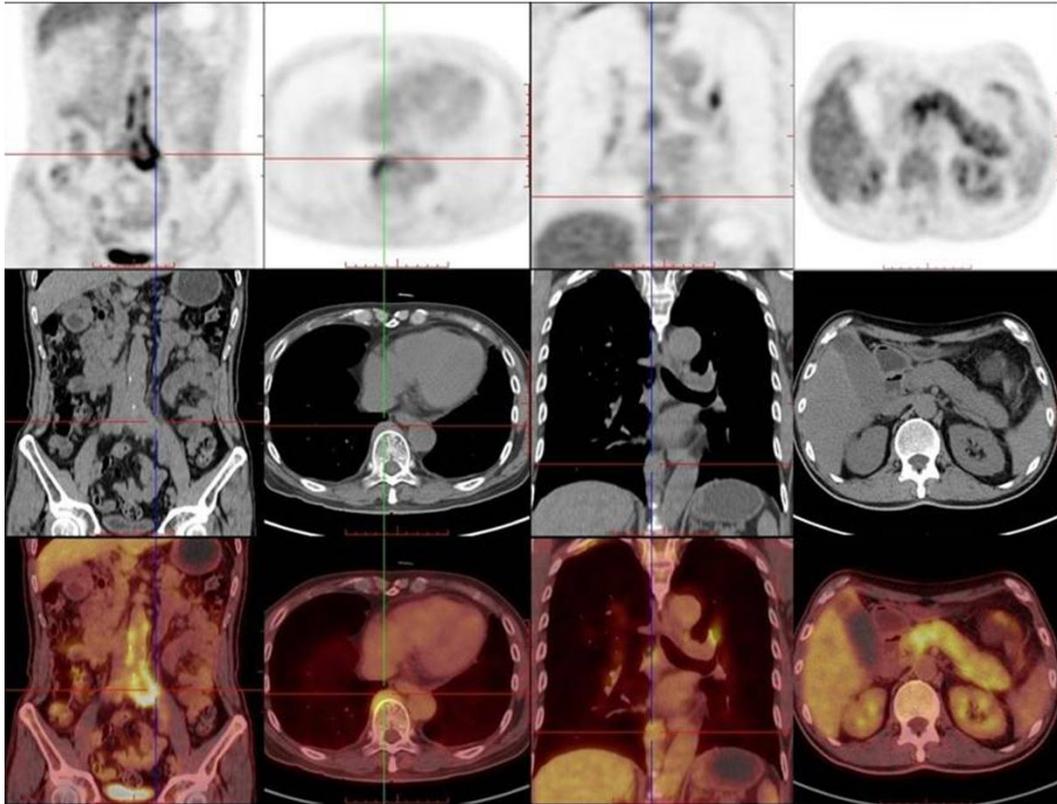
脂膜炎 (panniculitis)



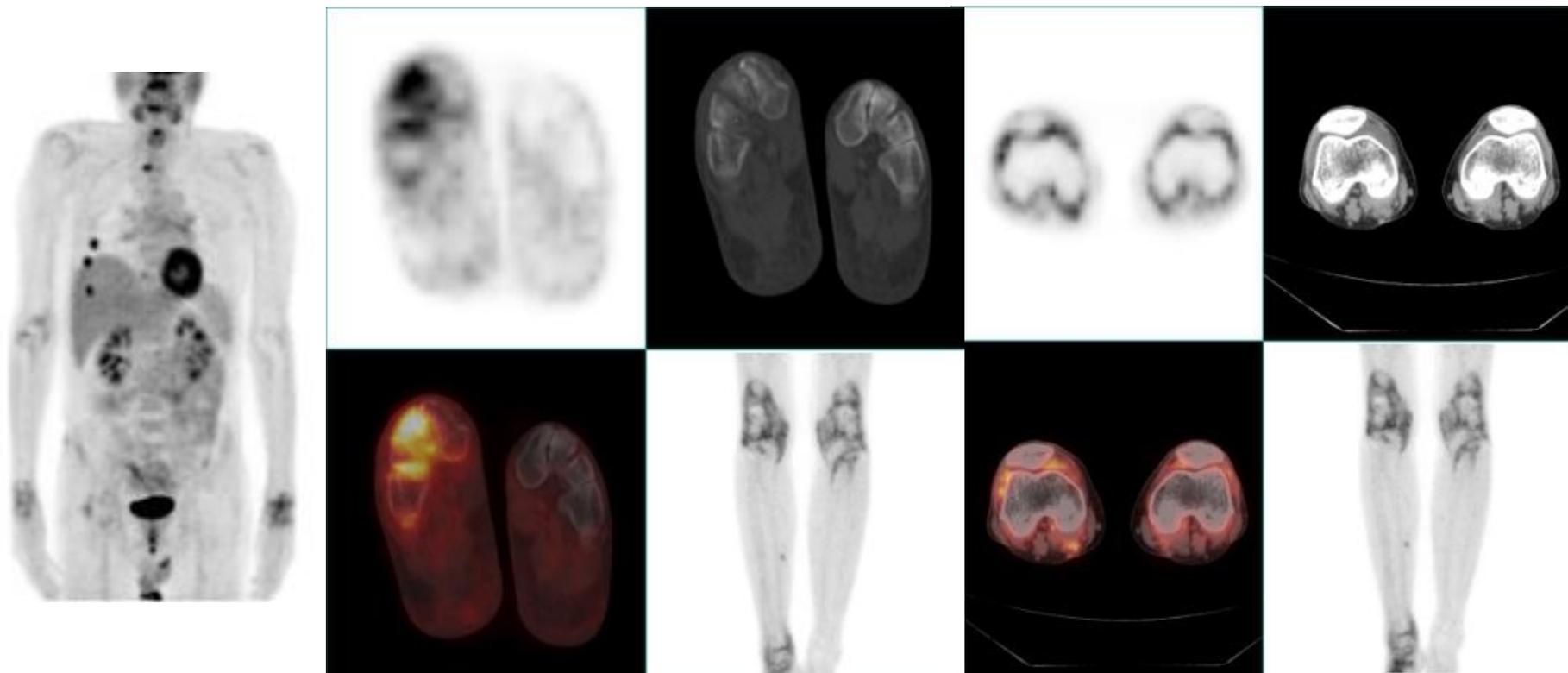
55岁女性，间断多关节疼痛
2个月，发热1月。



■ IgG4RD

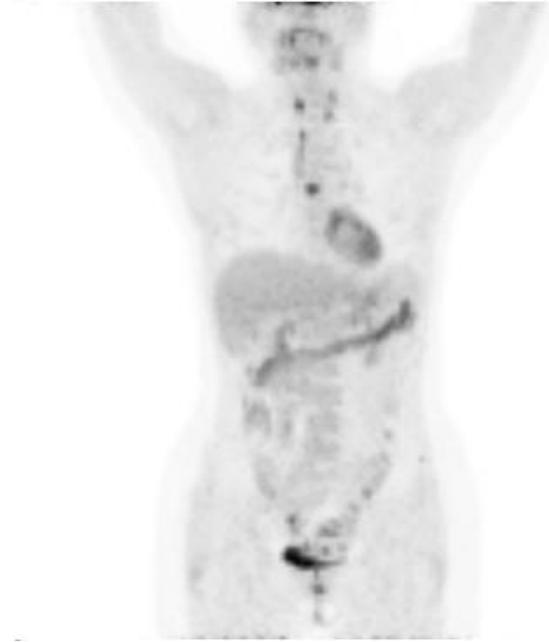


反应性关节炎 (*reactive arthritis*)



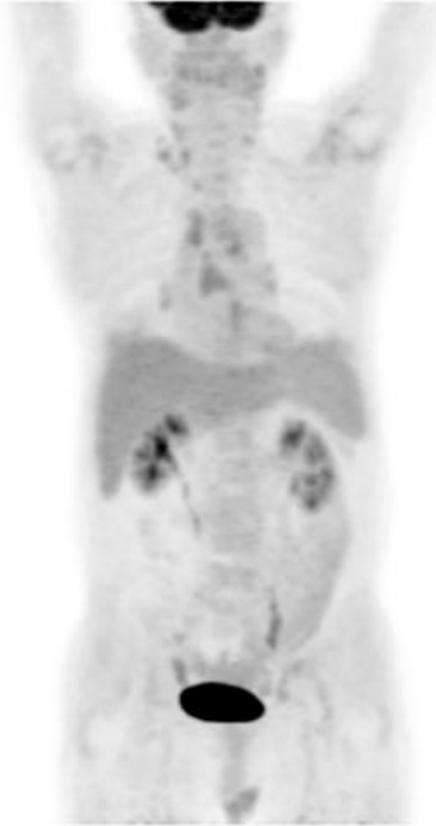
人类白细胞抗原 (HLA) -B27相关; 属血清阴性脊柱关节病范畴

FUO/IUO中的其他病因



停药后症状好转，
3个月后复查PET/CT

53岁女性，2个月前服用中药后出现皮肤红色丘疹，1个月前出现发热及关节肿痛，予抗生素抗感染治疗无好转，体温最40.5° C，伴畏寒、咽痛、枕后淋巴结肿大。实验室检查：ANA 1:40，中性粒、嗜酸性粒细胞百分比5.08%、ALT 96U/L、AST 53U/L。



Castleman病



坏死性淋巴结炎



甲亢

PET/CT对发热待查患者的诊疗作用

鉴别

Infection

Connective tissue diseases

Malignancy

Miscellaneous

Unknown

多重信息提供

检出/排除
恶性肿瘤

疗效观察
预后判断

提示适宜
活检部位



显示病变
活动状态

提供疾病
特征信息

指导实验性
治疗

结合临床的影像诊断
可帮助解决更多临床诊疗难题



谢谢!