· 述评 ·

PET 和 SPECT 心肌灌注显像测定冠状动脉血流储备

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Assessment of coronary flow reserve with PET and SPECT imaging

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90%以上的冠状动脉(简称冠脉)血管是直径小于 500 μm 的微血管。近年来,越来越多的证据表明,冠脉微血管功能障碍(coronary microvascular dysfunction, CMD)在冠脉粥样硬化性心脏病(简称冠心病)的发病和心脏事件发生中起着重要作用,其有时甚至是唯一的致病机制[1-2]。根据微血管病变的不同病因,可将 CMD 分为不合并阻塞性冠脉疾病、合并阻塞性冠脉疾病和其他类型的微血管病变 3 种类型。CMD 不仅仅存在于冠心病,多种心血管疾病都可以单独或合并存在 CMD[3-4],如临床发病率较高的肥厚型心肌病,CMD 就是其重要的病理机制之一。

2012 年,美国心脏病学会基金会(American College of Cardiology Foundation, ACCF)/美国心脏协会(American Heart Association, AHA)/美国医师协会(American College of Physicians, ACP)/美国胸外科协会(American Association for Thoracic Surgery, AATS)/美国心血管预防护理协会(Preventive Cardiovascular Nurses Association, PCNA)/美国心血管造影和介入学会(Society for Cardiovascular Angiography and Interventions, SCAI)/美国胸外科医师学会(Society of Thoracic Surgeons, STS)的稳定性冠心病诊断和管理指南指出,相对男性而言,与微血管和内皮功能异常相关的血管反应会更大程度地造成女性局部心肌缺血[5]。2017 年,冠脉血管舒缩障碍国际研究学组(Coronary Vasomotion Disorders International Study Group)明确提出了微血管心绞痛的临床诊断标准[6]。同年,中国发布了《冠状动脉微血管疾病诊断和治疗的中国专家共识》[7]。欧洲心脏病学会(European Society of Cardiology, ESC)指南提出,冠心病不单是大血管的局部狭窄[8],肯定了冠脉痉挛和 CMD 在心肌缺血中的致病作用[9]。

目前,已有多种有创和无创方法用于 CMD 的诊断,无创性影像技术无疑具有更大的优势和患者的可接受性[10-11]。PET 可以定量测定静息和冠脉扩张状态下的心肌血流量,进而测量冠脉血流储备(coronary flow reserve, CFR),是测定 CFR 的"金标准"[12]。在冠脉造影或冠脉 CT 成像排除心外膜冠脉血管明显狭窄和弥漫性冠脉狭窄的情况下,CFR 减低被用来代表 CMD。PET 测定 CFR 在国外一些医院已得到了很好的临床应用,其在冠心病等心血管疾病患者的诊断、预后评估中的价值已得到一系列研究的证实[13-15]。近年来,SPECT 心肌灌注显像在国外被应用于评价 CMD,尤其是基于碲锌镉(cadmium zinc telluride, CZT)晶体的新型心脏专用 SPECT 仪(CZT-SPECT)显像,初步研究表明其结果与 PET 显像具有非常好的相关性[16-17]。在国内,PET 测定 CFR 也开始逐渐应用,几个医院分别发表了 PET 测定 CFR 初步临床应用论文[18-19],PET 测定 CFR 的临床应用经验正在积累中。同时,新型心脏专用 SPECT 心肌灌注显像也在我国开始被应用于评价 CMD。

本期重点号发表了 3 篇关于放射性核素显像测定心肌血流量的论著[20-22],其中关于 PET 和 SPECT 测定 CFR 临床应用的论著各 1 篇、探讨 SPECT 测定 CFR 技术的论著 1 篇。彭琨等[20]探讨了 $^{13}N-NH_3 \cdot H_2O$ PET/CT 显像测定的 CFR 对可疑冠脉微血管疾病(coronary microvascular disease, CMVD)患者的诊断

价值,该研究回顾性分析了 54 例临床疑诊 CMVD 患者经 $^{13}N\text{-}NH_3 \cdot H_2O$ PET/CT 显像测定的 CFR,并比较 CMVD 组(CFR<2.5)和非 CMVD 组(CFR≥2.5)的差异,结果表明,PET/CT CFR 测定的诊断能力优于心肌灌注显像的半定量分析,该研究为冠脉造影或冠脉 CT 成像阴性狭窄、疑诊 CMVD 的患者提供了无创性、客观的诊断和评价依据。陈炜佳等[21]探讨了 CZT-SPECT(以色列 Spectrum Dynamics Medical,D-SPECT)测定 CFR 对心肌灌注显像诊断冠心病的增益价值,他们回顾性分析 132 例完成静息/负荷心肌灌注显像和 CFR 测定的疑似或确诊冠心病患者的影像资料,以冠脉造影结果为"金标准",计算并比较了心肌灌注显像与心肌灌注显像联合 CFR 测定诊断冠心病的效能。结果显示,CFR 可明显提高心肌灌注显像诊断冠心病的灵敏度和准确性,尤其是对于多支冠脉病变和轻度冠脉狭窄的患者。马荣政等[22]以多针孔 CZT-SPECT(美国 GE,NM530c)定量测定心肌血流量,研究表明,在动态 SPECT 图像后处理过程中,完整的物理校正能提高数据-模型的一致性和降低左心室血池溢出效应,进而提高心肌血流定量准确性。

CMD 存在于多种心脏疾病。不同心脏疾病的发病和进展过程中,CMD 的角色和占比可能并不相同。深入探讨 CMD 在主要心脏疾病(尤其是冠心病)中的作用,有助于对相关心血管疾病的防治。多种影像技术可互为补充,利用多模态影像技术对 CMD 进行全面的诊断、评价与监测,从而不断完善对 CMD 的认知和心血管疾病的诊治。目前,已有多种无创影像技术可用于 CMD 的诊断,虽然各有其优势,但也有不同程度的不足。放射性核素显像有一定的优势,但仍有一些问题亟需解决和完善。

利益冲突 所有作者均声明不存在利益冲突

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2019 年本刊可直接用缩写的常用词汇

ATP(adenosine-triphosphate),三磷酸腺苷
CI(confidence interval),可信区间
CT(computed tomography),计算机体层摄影术
CV(coefficient of variation),变异系数
DNA(deoxyribonucleic acid),脱氧核糖核酸
HAV(hepatitis A virus),甲型肝炎病毒
Hb(hemoglobin),血红蛋白
HBsAg(hepatitis B surface antigen),乙型肝炎表面抗原
HBV(hepatitis B virus),乙型肝炎病毒
HCV(hepatitis C virus),丙型肝炎病毒
MRI(magnetic resonance imaging),磁共振成像
PCR(polymerase chain reaction),聚合酶链反应
PET(positron emission tomography),正电子发射体层摄影术
PLT(platelet count),血小板计数
RBC(red blood cells),红细胞
RNA(ribonucleic acid),核糖核酸
SPECT(single photon emission computed tomography),单光子发射计算机体层摄影术
WBC(white blood cells),白细胞
WHO(World Health Organization),世界卫生组织

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