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^{18}F-FDG PET-CT肿瘤体积测量在胃癌分期中的应用

潘庆芳[1]，颜有霞[2*]

[1]青海大学临床医学院，青海 西宁
[2]青海省人民医院，核医学科，青海 西宁

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摘 要

由于positron emission tomography-computed tomography (PET-CT)三维解剖的病灶体积测量，可以从各层面全方位测量有代谢活性的肿瘤组织的体积，肿瘤体积(Gross Tumor Volume, GTV)测量不受空腔脏器的蠕动、膨胀程度的影响，从而探讨胃癌体积测量与胃癌病理分期中的相关性及临床应用意义。因此PET-CT肿瘤体积测量在胃癌分期中有着前瞻性评估作用，可以为患者治疗方式提供依据。

关键词

胃癌，肿瘤体积，测量

Application of ^{18}F-FDG PET-CT Tumor Volume Measurement in Gastric Cancer Staging

Qingfang Pan[1], Youxia Yan[2*]

[1]The Clinical Medical College of Qinghai University, Xining Qinghai
[2]Department of Nuclear Medicine, Qinghai People's Hospital, Xining Qinghai

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Abstract

Due to the positron emission tomography-computed tomography (PET-CT) three-dimensional

*通讯作者。

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anatomical focus volume measurement, the volume of metabolically active tumor tissue can be measured from all levels, and the Gross Tumor Volume (GTV) measurement is not affected by the peristalsis and expansion of hollow organs to explore the correlation and clinical application significance of gastric cancer volume measurement and gastric cancer pathological staging. Therefore, PET-CT tumor volume measurement has a prospective evaluation role in gastric cancer staging, and can provide a basis for patient treatment.

Keywords

Gastric Cancer, Tumor Volume, Measurement

1. 背景

胃癌是世界上第五大最常见的癌症，起源于胃黏膜上皮，同时也是第三大最常见的死亡原因。在我国西北与东部最常见[1]。胃癌可发生于胃的任何部位，绝大多数胃癌属于腺癌，其中半数以上发生于胃窦部。这些统计数据与早期晚期肿瘤分期和显著百分比的局部复发和远处转移相关，目前我国胃癌的早期诊断率仍较低，故胃癌早期易被忽略，当发现时其手术治疗的结果并不令人满意，尤其是在胃癌晚期[2]。肿瘤比大多数其他组织消耗更多的葡萄糖，因为糖酵解增加，这一特征被利用在 PET 中使用 ^{18}F-fluorodeoxy-glucose (^{18}F-FDG)作为示踪剂[3]。FDG 羟基被 ^{18}F 取代。尽管化学成分不同，但细胞对 FDG 的吸收与葡萄糖的吸收是相似的。FDG 经葡萄糖转运体(glucose transporter, GLUTs)的介导运到细胞内，并被己糖激酶磷酸化，FDG-磷酸盐不再进一步被酵解，因而滞留在细胞内[4]。肿瘤的血管系统发育良好，这是葡萄糖和氧气充足输送的必要条件。肿瘤中葡萄糖代谢的增加部分是由肿瘤缺氧通过缺氧诱导因子(hypoxia inducible factor, HIF)的活动驱动的；但增殖的增加也会增加葡萄糖的利用[5] [6]。

胃癌的分期通常做两次[7] [8]：临床(c)阶段是在任何治疗前给出的等级。它是基于体检、活检和影像学检查。例如 cN2 或 cM1。临床(术前)阶段是基于内镜超声(Endoscopic ultrasound, EUS)和其他影像学或活检结果。这些检查是在任何治疗之前进行的，作为初步诊断的一部分。病理阶段(p)或手术阶段是通过检查手术中移除的组织来确定的。例如 pN2。如果在手术前接受药物治疗，那么这个阶段可能看起来像 ypT3。病理(术后)阶段是基于手术切除全部或部分胃和附近淋巴结后获得的信息。这可以更准确地了解癌症扩散的程度，并用于决定术后的治疗方案。肿瘤组织及邻近淋巴结的切除是病理分期的重要组成部分。病理分期参照 American Joint Committee on Cancer (AJCC)胃癌 TNM 分期[7]：TNM 分期代表肿瘤、淋巴结、转移。TNM 系统用于胃癌的分期，字母 T、N 和 M 描述了癌症发生的不同区域。

2. ^{18}F-FDG PET-CT 体积测量在胃癌分期中的诊断价值

胃肿瘤和邻近淋巴结的完全切除是唯一可能治愈的干预措施。计算机断层扫描(computed tomography, CT)仍然是胃癌术前分期和随访的重要方式。然而，CT 对非肿大淋巴结转移、腹膜播散和血行转移的识别可能有限。具有 ^{18}F-FDG 的正电子发射断层扫描已被公认为临床肿瘤学中有用的诊断技术，已广泛用于胃癌患者的诊断、分期、再分期、治疗反应评估和预后预测[8]。^{18}F-FDG PET 比 CT 具有更大的检查范围。虽然 ^{18}F-FDG PET 在检测胃癌方面不是合适的首先诊断方法，但它可能在检测远处转移(如肝、肺、

肾上腺的转移)中发挥重要作用，例如卵巢和骨骼等。^{18}F-FDG PET 还有助于接受化疗的患者进行随访，因为它可以识别对治疗的早期反应。目前仍需要进一步的研究来确定 ^{18}F-FDG PET 在检测局部淋巴结转移和腹膜播散方面的功效。然而，CT 和 PET 的联合使用有助于胃癌的术前分期和受影响患者的治疗监测[9] [10]。

胃癌确诊后，准确的术前分期，特别是关于壁浸润深度、邻近器官浸润、淋巴结受累和远处转移，对于确定最合适的治疗方法和避免不适当的治疗性手术尝试至关重要[11]。CT 已成为胃癌患者术前评估和分期的首选方式。此外，CT 是确定复发肿瘤的存在及其对化疗反应的主要工具；然而，其应用有限，尤其是在淋巴结转移、腹膜转移和血源性转移的诊断中[11] [12]。在初次诊断时，^{18}F-FDG PET 在确定可切除性和检测远处转移性疾病方面似乎非常准确，但在局部区域分期中的应用可能有限[13] [14]。PET 对胃癌 T 分期的帮助有限，因为它是一种功能成像方式。在原发性肿瘤检测中，发现胃腺癌(如粘液癌、印戒细胞癌)和低分化腺癌与其他组织学类型的胃癌相比，其 FDG 摄取明显降低[15] [16]。在 AJCC 分期标准下，胃癌 N 分期基于阳性淋巴结的数量(N1：1 到 2 个区域淋巴结的转移；N2：3 到 6 个淋巴结的肿瘤转移；N3：7 个以上淋巴结的癌转移) [7]。这种方法不同于以前基于解剖节点位置的分类。一些研究证实了阳性淋巴结数量在估计预后方面的优势[17] [18] [19]。PET 对胃癌 M 分期的帮助已得到公认。原发性胃癌的实体器官转移在初次诊断时不常见，但其检测在治疗计划中很重要。胃癌的血行转移最常累及肝脏，因为胃由门静脉引流[20]。其他较不常见的血行扩散部位包括肺部、肾上腺和骨骼[21]。在卵巢转移(Krukenberg 肿瘤)的情况下，考虑了三种可能的途径：腹膜播散、淋巴播散和血行播散。Krukenberg 肿瘤通常较大且双侧，CT 表现为附件实性肿块，伴有不均匀对比剂增强。与其他影像检查方法相比，FDG PET 的主要优势在于其有助于检测远处实体器官转移[22]。FDG PET 很容易发现肝、肺、肾上腺和卵巢的转移。有研究表明，FDG PET 是诊断结直肠癌、胃癌和食管癌肝转移最敏感的无创成像方式。理论上，CT 可能会漏掉小的肝转移，因具有高背景对比，故在 FDG PET 上可以很好地看到[23] [24]。

胃癌患者的预后仍然很差，尽管近年来各种治疗方式取得了进展。胃癌的传播一般遵循的主要模式是血行转移、淋巴结转移、种植转移及直接浸润。因胃癌预后与残留肿瘤有着密切关系，故在术前或单独的放射治疗中肿瘤大小尤其重要[25] [26] [27] [28]。胃癌术后局部复发与胃癌转移一样常见，其风险主要取决于胃壁的浸润深度和淋巴结的累及。肿瘤体积的大小在胃癌放射治疗中发挥着重要作用[29] [30]。在近端肿瘤中，精准的靶体积可以避免大肠和肾脏的照射。对于侵犯食管远端的肿瘤，应考虑更完整地覆盖纵隔淋巴结，特别是在一般情况良好的患者。有研究表明[31]放疗－术后化疗联合有良好效果，胃癌通过血行转移、淋巴结转移、种植转移及直接浸润，病灶位于一个大小和形状随时变化的器官。患者接受放化疗时，肝脏、肾脏及小肠最容易受到影响的器官。

临床上，^{18}F-FDG PET-CT 已广泛用于胃癌患者的诊断、分期、再分期、治疗反应评估和预后预测[32] [33] [34]。通常，癌症的 FDG 摄取量较低，但具有高度侵袭性，如低分化腺癌、印戒细胞癌和粘液腺癌。这些肿瘤通常表现为代谢活性低。一般的影像方法检查胃部疾病时经常受胃生理学蠕动及膨胀程度影响，而肿瘤体积大小则不受空腔脏器的蠕动、膨胀程度的影响，可以使胃癌分期更准确，从而指导治疗方案，改善病人生存率及健康水平。总之，通过 PET-CT 三维解剖的病灶体积测量不受空腔脏器的蠕动、胃壁厚度、肿瘤大体形态和胃膨胀程度的影响，这是其他影像学检查方法无法比拟的[35] [36]。

3. 小结

对胃癌患者行 PET-CT 检查，得出融合图像后勾画肿瘤体积范围，分析病灶的 TNM 分期，精准测量有代谢活性的癌组织体积以及对周围组织的侵犯，与病理结果对照分析。PET-CT 检查可为临床提供全面、准确、可 靠的诊断依据，对术前评估病灶可切除性及切除范围具有重要指导意义，这是其他任何一项检

查都不能够达到的。因为 PET-CT 诸多的优点，在国际上和国内发达城市 PET-CT 已广泛应用于临床，在胃癌分期的研究中，评价胃癌患者勾画 PET-CT 体积测量(GTV)在胃癌病理分期中的相关性及临床应用意义。将 PET-CT 图像与病理切片对照，阐明胃癌分期的重要性。PET-CT 对胃癌病灶体积的测量，能够为临床分期提供指导性的个体化影像学依据，值得临床推广应用。

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