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不同放射剂量 CT 在早期非小细胞肺癌中筛检价值对比 *

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摘要 目的:探讨与对比不同放射剂量计算机断层扫描(Computed Tomography, CT)在早期非小细胞肺癌中筛检价值。**方法:**2020年1月到2020年12月选择在本院经病理确诊为肺内磨玻璃样结节患者98例作为研究对象,所有患者都给予常规剂量正电子发射计算机断层扫描(Positron emission tomography, PET)/CT检查与低剂量PET/CT检查,记录成像特征、辐射剂量并判定筛检价值。**结果:**低剂量PET/CT对肺部增厚、边界不规则、钙化、囊变的检出率高于常规剂量PET/CT($P<0.05$)。低剂量PET/CT与常规剂量PET/CT的图像质量优良率为98.0%和96.9%,对比差异无统计学意义($P>0.05$)。低剂量PET/CT的有效放射剂量、剂量长度乘积低于常规剂量PET/CT($P<0.05$)。低剂量PET/CT的最大标准摄取值(maximum standardized uptake value, SUVmax)值低于常规剂量PET/CT($P<0.05$)。低剂量PET/CT与常规剂量PET/CT分别筛检非小细胞肺癌51例与37例,筛检敏感性分别为98.1%和69.2%,特异性分别为100.0%和97.8%。**结论:**低放射剂量PET/CT在肺结节中的应用不会影响图像质量,且能降低辐射剂量,提高对早期非小细胞肺癌患者的筛检效果。

关键词:计算机断层扫描;正电子发射计算机断层扫描;非小细胞肺癌;剂量;最大标准摄取值

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Comparison of the Value of CT with Different Radiation Doses in Screening Early Non-small Cell Lung Cancer*

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ABSTRACT Objective: To explore and compare the value of computer tomography(CT) with different radiation doses in the screening of early non-small cell lung cancer. **Methods:** From January 2020 to December 2020, 98 cases of patients with ground glass nodules in the lungs diagnosed pathologically in our hospital were selected as the research subjects. All cases were given conventional-dose positron emission tomography (PET)/CT examination and low-dose PET/CT examination, recorded the imaging characteristics, radiation dose and determined the value of screening. **Results:** The detection rates of low-dose PET/CT for lung thickening, irregular borders, calcification, and cystic degeneration were higher than that of conventional-dose PET/CT($P<0.05$). The excellent and good image quality rates of low-dose PET/CT and conventional-dose PET/CT were 98.0 % and 96.9 %, and the difference were not statistically significant($P>0.05$). The effective radiation dose and dose length product of low-dose PET/CT were lower than conventional-dose PET/CT($P<0.05$). The maximum standardized uptake value(SUVmax) of low-dose PET/CT were lower than that of regular-dose PET/CT($P<0.05$). Low-dose PET/CT and conventional-dose PET/CT were used to screen 51 and 37 cases of non-small cell lung cancer, respectively, so that the screening sensitivity were 98.1% and 69.2%, and the specificity were 100.0 % and 97.8 %, respectively. **Conclusion:** The application of low-dose PET/CT in pulmonary nodules will not affect the image quality, and can reduce the radiation dose and improve the screening effect for patients with early non-small cell lung cancer.

Key words: Computed tomography; Positron emission tomography; Non-small cell lung cancer; Dose; Maximum standard uptake value

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前言

非小细胞肺癌是临床上最常见的呼吸道肿瘤之一,但是由

于缺乏有效的早期检测诊断方法,很多患者在就诊时被诊断为晚期,失去了根治性手术的可能,导致死亡率一直居高不下^[1,2]。该病的发生机制还不明确,不过可能是先天性与后天性因素共

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同作用的结果,包括吸烟、肺炎、体细胞突变、基因扩增和缺失、基因失活和异常 DNA 甲基化、不良饮食习惯等^[3,4]。非小细胞肺癌多由肺内磨玻璃样结节发展而来,但是早期非小细胞肺癌与良性肺结节的临床特征比较类似,为此对于临床诊断的要求比较高^[5,6]。计算机断层扫描(Computed Tomography, CT)具有可精确定位病灶、图像分辨率高等特点,可反映肺部及肺外组织如淋巴结及附近脏器的受累情况^[7]。正电子发射计算机断层扫描(Positron emission tomography, PET)对细胞代谢比较敏感,可利用各种肿瘤示踪剂观察脏器的动态变化,但是诊断分辨率较低^[8,9]。PET/CT 融合图像精确定位及判断病灶的良恶性,也可以全面发现病灶,从而能早期诊断病灶;并且在进行精确解剖定位的同时,可提供全身显像^[10,11]。随着 CT 的广泛应用,CT 辐射对非小细胞肺癌患者的损伤也被广泛重视^[12]。低剂量 CT 是在常规 CT 基础上通过调整扫描参数而来,以减少辐射对身体的穿透与伤害程度^[13]。已有研究显示低剂量 CT 在适当范围内降低管电流即可达到对肺癌的诊断目的,又能降低辐射剂量^[14]。本文具体探讨与对比了不同放射剂量 CT 在早期非小细胞肺癌中筛查价值,以明确低剂量 CT 筛查的效果。现总结报道如下。

1 资料与方法

1.1 研究对象

2020 年 1 月到 2020 年 12 月选择在本院经病理确诊为肺内磨玻璃样结节患者 98 例作为研究对象,纳入标准:初诊患者;年龄 30~70 岁;单肺病变;所有入选者在接受 PET/CT 诊断前未接受治疗;临床表现为咯血、胸闷、憋气、急性发热、咳嗽、咳痰等症状;本研究获得医学伦理委员会的批准;病历资料完整;所有入选者签署了知情同意书。排除标准:妊娠与哺乳期妇女;伴有其他部位恶性肿瘤者;全身感染性疾病者;严重凝血功能障碍者;临床与影像学资料缺乏者;精神疾病患者。

其中男 53 例,女 45 例;年龄最小 30 岁,最大 70 岁,平均年龄 48.94 ± 4.44 岁;平均体重指数 22.47 ± 1.22 kg/m²;平均收缩压 126.18 ± 12.47 mmHg;平均收缩压 79.13 ± 10.34 mmHg;平均心率 97.28 ± 10.47 次/分;发病位置:左肺 48 例,右肺 50 例。

1.2 PET/CT 检查方法

使用德国 SIEMENS 公司 PET-CT Biograph 64 型检查设备,显像剂为 18- 氟代脱氧葡萄糖 (β -2-[18F]-Fluoro-2-deoxy-D-glucose, 18F-FDG)。患者检查前需禁食 6 h 左右,于手臂静脉注射 18F-FDG,剂量 3.70~4.81 MBq/kg)。平均呼吸,静卧休息 60 min 后行全身 PET/CT 扫描。扫描范围从颅顶至股骨上端。螺旋 CT 扫描,层厚 5 mm,螺距 0.75:1。

常规剂量 CT 检查:管电压 110 Kv、管电流 200 mA、重建层厚为 3.0 mm。

低剂量 CT 检查:管电压 110 Kv、管电流为 25 mA、重建层厚 2.5 mm。

然后使用 2D/3D 模式行 PET 采集,采用迭代法重建,每个床位 3 min,共 6 个床位。采集结束后数据行 PET/CT 图像融合,由 2 名中高级职称的医生在掩盖扫描条件下独立对各组图像进行判定,意见不一致时由科里集体讨论得出。

1.3 观察指标

(1)记录所有患者 CT 常规特征,包括肺部增厚、边界不规则、钙化、囊变等。(2)图像评价的参照标准依据肺壁清晰度、肺部增厚、结节清晰度、肝脾等实质脏器清晰度、肺外间隙清晰度等 5 个维度进行判定,每个维度分为 1~3 分评分,总分 12~15 分为图像质量优,8~11 分为图像质量良,<8 分为图像质量差。(3)记录所有患者的有效放射剂量与剂量长度乘积(dose length produce, DLP)。(4)用半定量分析法和测定所有患者的 FDG 最大标准摄取值 (maximum standardized uptake value, SUVmax)。(5)以患者的病理诊断结果作为金标准,判断筛查价值。

1.4 统计方法

选择 SPSS 20.00 软件对本研究所有数据进行分析,计量数据以均数 $\pm$ 标准差等表示,计数数据以百分比表示,计量数据对比采用 t 检验,计数数据对比采用卡方 χ^2 分析,检验水准为 $\alpha=0.05$ 。

2 结果

2.1 常规 CT 特征对比

低剂量 PET/CT 对肺部增厚、边界不规则、钙化、囊变的检出率高于常规剂量 PET/CT ($P<0.05$),见表 1。

表 1 不同剂量下的常规 CT 特征对比(例,%)

Table 1 Comparison of conventional CT features under different doses (n,%)

Dose	n	Lung thickening	Irregularity boundary	Calcification	Cystic change
PET/CT of low doses	98	51(52.0)*	50(51.0)*	52(53.1)*	50(51.0)*
PET/CT of conventional dosage	98	36(36.7)	34(34.7)	38(38.8)	35(35.7)

Note: *Compared with the PET/CT of conventional dosage, $P<0.05$.

2.2 图像质量对比

低剂量 PET/CT 与常规剂量 PET/CT 的图像质量优良率为 98.0% 和 96.9%,对比差异无统计学意义($P>0.05$),见表 2。

2.3 剂量参数对比

低剂量 PET/CT 的有效放射剂量、剂量长度乘积低于常规剂量 PET/CT ($P<0.05$),见表 3。

2.4 SUVmax 值对比

低剂量 PET/CT 的 SUVmax 值低于常规剂量 PET/CT ($P<0.05$),见表 4。

2.5 筛查价值对比

在 98 例患者中,病理诊断为非小细胞肺癌 52 例,良性结节 46 例;低剂量 PET/CT 与常规剂量 PET/CT 分别筛查非小细胞肺癌 51 例与 37 例,筛查敏感性分别为 98.1%(51/52)和 69.2%(36/52),特异性分别为 100.0%(46/46)和 97.8%(45/46),见表 5。

表 2 不同剂量下的图像质量对比(例, %)

Table 2 Comparison of image quality under different doses (n, %)

Dose	n	Excellent	Good	Difference	Excellent rate
PET/CT of low doses	98	88(89.8)	8(8.2)	2(2.0)	96(98.0)
PET/CT of conventional dosage	98	86(87.8)	9(9.2)	3(3.1)	95(96.9)

表 3 不同剂量下的剂量参数对比($\text{mGy}\cdot\text{cm}$, $\bar{x}\pm s$)Table 3 Comparison of dose parameters under different doses ($\text{mGy}\cdot\text{cm}$, $\bar{x}\pm s$)

Dose	n	Effective radiation dose	Dose length product
PET/CT of low doses	98	$0.65\pm 0.05^*$	$41.39\pm 2.15^*$
PET/CT of conventional dosage	98	0.90 ± 0.06	54.09 ± 3.11

Note: *Compared with the PET/CT of conventional dosage, $P<0.05$.

表 4 不同剂量下的 SUVmax 值对比($\bar{x}\pm s$)Table 4 Comparison of SUVmax values under different doses ($\bar{x}\pm s$)

Dose	n	SUVmax value
PET/CT of low doses	98	$4.56\pm 0.11^*$
PET/CT of conventional dosage	98	9.29 ± 0.09

Note: *Compared with the PET/CT of conventional dosage, $P<0.05$.

表 5 低剂量 PET/CT 与常规剂量 PET/CT 在筛选非小细胞肺癌的敏感性与特异性(例, %)

Table 5 The sensitivity and specificity of low-dose PET/CT and conventional-dose PET/CT in screening non-small cell lung cancer (n, %)

Pathology	PET/CT of low doses		PET/CT of conventional dosage		Total
	Nonsmall-cell lung cancer	Benign nodules	Nonsmall-cell lung cancer	Benign nodules	
Nonsmall-cell lung cancer	51	1	36	16	52
Benign nodules	0	46	1	45	46
Total	51	47	37	61	98

3 讨论

肺内磨玻璃样结节在病理上表现为肺泡腔内含气量减少、肺泡间隔增厚、肺泡上皮细胞不均匀增生等。其也是一种非特异性的影像学表现,可由多种病变引起,包括良性结节、炎症性病变、局限性纤维化、恶性肿瘤等,为此需要进行早期鉴别诊断^[15]。

CT 为临床上的常见影像学诊断方法,可提供肺泡内信息,反映结节大小、部位及其与周围脏器关系,也可反映肺壁及肺泡外组织的受累情况,从而指导手术方式的选择^[16]。不过有研究显示早期非小细胞肺癌与肺良性结节的 CT 图像均可表现为腔内包块、肺部增厚等,导致鉴别诊断较困难^[17]。PET 显像是在细胞和分子水平反应机体特点的功能分子显像设备, PET/CT 集解剖与功能显像于一体,是近年来发展起来的新型检查设备,能够同时提供 PET 图像与 CT 图像,其已经在恶性肿瘤的定性诊断、临床分期与预后预测中发挥了重要的优势^[18,19]。本研究显示低剂量 PET/CT 对肺部增厚、边界不规则、钙化、囊变的检出率高于常规剂量 PET/CT; 低剂量 PET/CT 与常规剂量 PET/CT 的图像质量优良率为 98.0 % 和 96.9 %, 对比差异无统计学意义。从机制上分析, PET/CT 不仅使 CT、PET 的原有优

势得到发挥,还可在一次检查中同时收集解剖信息和分子生物信息。特别是低剂量检查可针对不同部位的检查动态调整所需辐射剂量,可以发现钙化、囊变等病灶,有助于非小细胞肺癌的术前诊断^[20]。

当前非小细胞肺癌的恶性进展速度已经超过治疗的治愈速度,并且临床症状缺乏特异性,术前确诊率低,也容易出现漏诊、误诊,从而影响患者的预后。PET/CT 图像融合可以动态观察肿瘤的形态变化,且能在肿瘤形态未有形态改变时,判断的肿瘤活性状态^[21,22]。SUVmax 值可反映肿瘤的恶性程度及细胞的代谢水平,也是肿瘤细胞对 FDG 的标准摄取值,是 PET/CT 用于诊断恶性肿瘤的重要参考指标之一。特别是非小细胞肺癌患者的瘤体细胞十分密集,无氧酵解很强,FDG 在细胞内储留时间延长,蓄积量很高,可导致 SUVmax 值增加^[23,24]。本研究显示低剂量 PET/CT 的有效放射剂量、剂量长度乘积都低于常规剂量 PET/CT; 低剂量 PET/CT 的 SUVmax 值低于常规剂量 PET/CT。从机制上分析,本研究的低剂量 PET/CT 从管电流、管电压、重建层厚方面都控制了辐射剂量,可不影响对非小细胞肺癌的检出能力,可在保证分割精度的情况下,减轻在检查过程中患者经受的放射伤害^[25]。并且随着现代数字图像处理技术

和理论不断发展,利用计算机技术指导 CT 剂量成为了可能,也可临床大规模推广应用低剂量 PET/CT 检查提供基础^[26,27]。

非小细胞肺癌的发生与发展、转移具有一系列连续和相互关联的过程,是由于肿瘤内外分子相互作用,使得新生的肿瘤细胞转化为具有高度转移与侵袭性的恶性肿瘤细胞^[28]。PET/CT 可实现对靶向区域的精确定位,可同时参考患者的功能图像信息和结构图像信息以辨别肿瘤,从而尽早做出诊断^[29]。本研究显示低剂量 PET/CT 与常规剂量 PET/CT 分别筛选非小细胞肺癌的敏感性分别为 98.1 %和 69.2 %,特异性分别为 100.0 %和 97.8 %。从机制上分析,肺组织细胞对 FDG 的生理性摄取较高,炎性、结节等因素也可导致肺组织细胞摄取大量 FDG 摄取,为此容易导致假阳性,导致筛选敏感性下降^[30,31]。而低剂量 PET/CT 能在最佳的扫描范围及放射浓度下,检查出非小细胞肺癌病变,还可以减少受到的辐射剂量,降低患者因此患其他肿瘤的可能性,提高患者检查的安全性^[32,33]。本研究也有一定的不足,患者数量较少,且没有单独进行病例分析,将在后续研究中深入探讨。

总之,低放射剂量 PET/CT 在肺结节中的应用不会影响图像质量,且能降低辐射剂量,提高对早期非小细胞肺癌患者的筛选效果。

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