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直径大于 3 厘米的周围型肺癌血流动力学的 多排螺旋 CT 动态增强扫描研究 *

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摘要 目的:研究直径 3 厘米以上周围型肺癌血流动力学的螺旋 CT(电子计算机断层扫描, Computed Tomography)动态增强扫描的特点。**方法:**选取我院收治的肿瘤直径 >3 cm 的周围型肺癌患者 55 例, 肺部腺瘤(良性)患者 10 例, 肺部炎性结节患者 26 例。分别进行螺旋 CT 动态增强扫描, 记录其 CT 值、强化峰值(Peak enhancement, PH), 绘制动态增强时间-密度曲线, 计算并比较曲线最大增强线性斜率(steepest slope, SS)以及血流灌注量(blood perfusion, BP)。**结果:**肺部炎性结节患者的密度曲线在 120 s 达到最大值; 肺癌患者的密度曲线至 65 s 达到高峰; 胸腺瘤患者的密度曲线变化不明显。肺癌组 PH 平均值大于胸腺瘤组, 差异有统计学意义($P < 0.05$); 胸腺瘤组 PH 平均值小于肺部炎性结节组, 差异有统计学意义($P < 0.05$); 肺癌组 SS 和 BP 大于胸腺瘤组, 差异有统计学意义($P < 0.05$); 胸腺瘤组 SS 和 BP 小于肺部炎性结节组, 差异有统计学意义($P < 0.05$)。**结论:**螺旋 CT 动态增强扫描能够反映直径 3 厘米以上周围型肺癌的血流动力学特点从而有助于在肺癌的诊断和鉴别诊断。

关键词:周围型肺癌; 血流动力学; 螺旋 CT; 增强

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Dynamic Enhanced Spiral CT Scan on the Hemodynamics of Diameter 3 cm above the Peripheral Lung Cancer*

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ABSTRACT Objective: To study the hemodynamic characteristics of dynamic scanning of a diameter of 3 cm or more peripheral lung cancer enhanced spiral CT. **Methods:** 55 cases of patients with peripheral lung cancer, thymoma (benign) of 10 patients, 26 cases of pulmonary inflammatory nodule in our hospital were selected. Under the dynamic enhanced spiral CT scan, recording its CT value, peak enhancement (PH), rendering dynamic time density curve, maximum enhancement steepest slope (SS) and blood perfusion (BP). **Results:** The density curve of patients in pulmonary inflammatory nodules group reached the maximum at 120 s, in lung cancer reached the maximum at 65 s, and in undulating thymoma group there was no change. The average value of PH in lung cancer group was significantly higher than that of the thymoma group ($P < 0.05$); the average PH in thymoma group was significantly lower than that of the pulmonary inflammatory nodule group ($P < 0.05$). Lung cancer group SS and BP is greater than the thymoma, the difference was statistically significant ($P < 0.05$); Thymoma group SS and BP is less than pulmonary inflammatory nodule group, the difference was statistically significant ($P < 0.05$). **Conclusion:** Dynamic enhanced spiral CT scan can reflect more than 3 cm in diameter of peripheral lung cancer hemodynamic characteristics so as to help in the diagnosis and differential diagnosis of lung cancer.

Key words: Peripheral lung cancer; Hemodynamics; Spiral CT; Enhancement

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前言

肺癌是由于细胞异常分化增殖而引起的一种恶性肿瘤性疾病^[1],其发病率和死亡率持续上升。资料表明^[2],近 50 年来世界肺癌的发病率和死亡率明显增高,已成为致死性恶性肿瘤的首位。该病临床表现^[3]早期可为咳嗽、痰中带血、胸痛、声音嘶哑、发热等,晚期会发生肺外转移,出现消瘦以及恶病质,危害

生命。肺癌分为中央型、周围型^[4],其中周围型肺癌包括腺癌和鳞癌,占肺癌的 30%,早期不明显,确诊时已错失手术机会。因此,周围型肺癌的诊断成为亟需解决的医学问题。目前,病理诊断是周围型肺癌诊断的金标准^[5],因其具有创伤性,难以为患者所接受。肿瘤标志物检测、x 线检查等手段没有明显的特异性。研究发现^[6],螺旋 CT 动态增强扫描可以观察肺癌特有的血流动力学改变,可作为肺部结节鉴别诊断的依据。目前研究主要集

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中在 3 厘米以下的肺部结节血流动力学研究^[7],而对于 3 厘米以上的周围型肺癌研究不足。我们观察 3 厘米以上周围型肺癌患者 CT 动态增强扫描下的血流动力学特点,为周围型肺癌的 CT 诊断提供临床依据。

1 资料与方法

1.1 一般资料

选取 2009 年 6 月至 2013 年 1 月于我院以周围型肺癌为诊断而收入院患者 55 例,其中男 38 例,女 17 例,平均年龄为 60.1 ± 6.7 岁,癌肿直径在 3 厘米以上,平均直径 5.4 ± 2.1 厘米;以胸腺瘤(良性)为诊断而收入院患者 10 例,其中男 6 例,女 4 例,平均年龄为 61.3 ± 5.9 岁,瘤体直径在 3 厘米以上,平均直径 4.1 ± 0.9 厘米;以肺部炎性结节为诊断而收入院患者 26 例,其中男 15 例,女 11 例,平均年龄为 58.3 ± 6.9 岁,结节直径在 3 厘米以上,平均直径 4.5 ± 1.3 厘米。三组患者的一般资料相仿,差异无统计学意义($P > 0.05$)。患者自愿参与本实验,并签署知情同意书。

1.2 纳入及排除标准

纳入标准:周围型肺癌、胸腺瘤患者均经支气管镜、病理穿刺证实;肺部炎性结节患者经抗炎治疗后,炎性病灶减小;病灶为孤立性;病灶均在 3 厘米以上;年龄在 50-70 岁。排除标准:存在多个病灶;病灶小于 3 厘米;因各种原因不能配合;肺结核患者。

1.3 检查方法

使用德国 Siemens Biograph 16 排螺旋 CT,首先进行胸部常规扫描,扫描螺距为 1.5,每层厚为 5 mm,确定以病灶为中心的增强扫描层面;之后,经前臂注入 100 mL 对比剂,注射速度为 2.5 mL/s,对比剂选用 300 mgI /m 的欧乃派克;从注射对比剂开始后的 10 s、20 s、30 s、40 s、50 s、60 s、90 s、120 s、180 s 均进行一次扫描,采用螺距 1,每层厚 3 mm。

1.4 数据处理

1.4.1 CT 值的测量 测量增强最明显区域的 CT 值以及此处平扫的 CT 值,两者之差即为强化峰值(英文全称,PH),计算各组平均 CT 值、平均 pH 值。

1.4.2 描绘动态增强时间 - 密度曲线 将三组患者不同时间扫描的 CT 值做成表格,利用 Excel 软件,以时间为横轴,以 CT 值为纵轴,分别描绘各组患者 CT 值得变化曲线,观察其形态及特点。

1.4.3 计算时间 - 密度曲线最大增强线性斜率 (steepest slope, SS) 首先找出各组曲线快速上升段最大的 CT 值(SCTend)及其时间点(Tend)、起时的 CT 值(SCTprior)及其时间点(Tprior),平扫的 CT 值(SCTo),Tend 与 Tprior 分别表示和 SCTend, SCTprior 相应的时间点(以秒为单位),之后根据公式^[8]计算: $SS = (SCTend - SCTprior) / [SCTo \times (Tend - Tprior)] \times 100\% (\%/s)$,并计算各组 SS 的平均值。

1.4.4 计算血流灌注量 (blood perfusion, BP) BP 为病灶组织时间 - 密度曲线上上升段最大斜率(TACSPN)与主动脉最大增强 CT 峰值(PHAA)的比值^[9],并计算各组 BP 的平均值。

1.5 统计学方法

采用统计学软件 SPSS19.0 进行统计学分析,计量资料采用 t 检验,计数资料采用卡方检验处理,以 $P < 0.05$ 为有显著性差异。

2 结果

2.1 各组患者的动态增强时间 - 密度曲线

从图中可以看出肺部炎性结节患者的密度曲线,起始快速上升,之后稍有波动,在 120 s 达到最大值后趋于平稳;肺癌患者的密度曲线起始段稳步上升,至 65 s 达到高峰,65 s 到 120 s 缓慢下降,之后维持平稳;胸腺瘤患者的密度曲线起伏不大,变化不明显,见图 1。

2.2 各组患者 PH 比较

肺癌组 PH 平均值明显小于肺部炎性结节组,差异有统计学意义($P < 0.05$);肺癌组 PH 平均值明显大于胸腺瘤组,差异有统计学意义($P < 0.05$);胸腺瘤组 PH 平均值明显小于肺部炎性结节组,差异有统计学意义($P < 0.05$),如表 1。

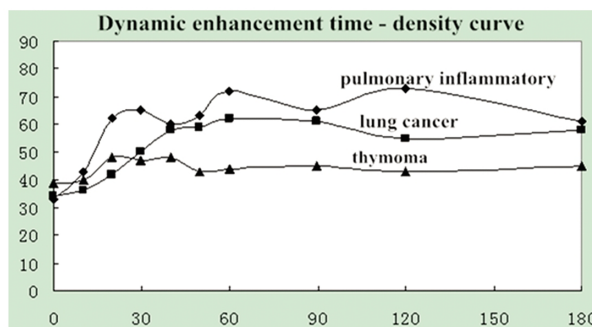


Fig.1 Dynamic enhancement time - density curve

Note: The horizontal axis is time (s); the vertical axis is PH(H4u).

表 1 各组患者 PH 比较情况(Hu)

Table 1 Comparison of PH(Hu)

Group	N	PH<20	20≤ PH<60	PH≥ 60	Mean
Lung cancer group	55	6	40	9	30.1± 13.4 [△]
Inflammatory nodule group	26	0	8	18	59.6± 15.1 [*]
Thymoma group	10	5	5	0	14.9± 4.3 [△]

Note: [△] $P < 0.05$, compared with pulmonary inflammatory nodules; ^{*} $P < 0.05$, compared with thymoma.

2.3 各组患者 SS、BP 比较

肺癌组 SS、BP 明显小于肺部炎性结节组,差异有统计学意义($P < 0.05$);肺癌组 SS、BP 明显大于胸腺瘤组,差异有统计

学意义($P < 0.05$);胸腺瘤组 SS、BP 明显小于肺部炎性结节组,差异有统计学意义($P < 0.05$),如表 2。

表 2 各组患者 SS、BP 比较情况

Table 2 Comparison of SS and BP

Groups	N	SS (%/s)	BP (mL·min ⁻¹ ·mL ⁻¹)
Lung cancer group	55	4.83± 4.32 [△] ※	1.17± 0.68 [△] ※
Inflammatory nodule group	26	7.96± 5.89※	2.01± 0.85※
Thymoma group	10	1.24± 0.78 [△]	0.18± 0.06 [△]

Note: [△]P<0.05, compared with pulmonary inflammatory nodules; ※P<0.05, compared with thymoma.

3 讨论

大量的研究资料表明^[13-15],周围型肺癌的诊断与鉴别诊断是影像学上的重点与难点,现代大多数的影像技术只能提供分叶、毛刺、胸膜凹陷等形态学上的特征,极易误诊。螺旋 CT 的出现,为肺癌的诊断提供了新思路,螺旋 CT 的动态增强扫描,突破了传统影像学检查的固定模式^[16],通过观察病灶注射对比剂后密度的动态变化,了解病灶是否有血液供应、血供的来源、变化等血液动力学特点,协助分析病灶的性质,为诊断提供更多依据^[17]。本研究即利用螺旋 CT 动态增强扫描直径 3 厘米以上周围型肺癌、肺部炎性结节、胸腺瘤,比较三者的 PH、SS、SP 差异,得出周围型肺癌的血流动力学特点,为其诊断提供支持。

研究结果显示,肺部炎性结节患者的密度曲线在 120 s 达到最大值;肺癌患者的密度曲线 65 s 达到高峰;胸腺瘤患者的密度曲线变化不明显。可以看出,肺部炎症性结节密度曲线变化较大,可能由于炎症因子的存在,使得炎症结节内部微血管扩张,血流速度较快,导致起始快速上升,之后由于淋巴回流、再循环等原因,曲线发生波动,达到最大值后对比剂随血液流走,趋于平稳;肺癌的密度曲线类似于胸主动脉的曲线,可能由于肺癌血供多来源于支气管动脉^[18-20],与胸主动脉血流条件相同;胸腺瘤内部一般无血液供应,故密度没有很大改变。本研究结果还显示,肺癌组 PH 平均值明显小于肺部炎性结节组(P<0.05);肺癌组 PH 平均值明显大于胸腺瘤组(P<0.05);胸腺瘤组 PH 平均值明显小于肺部炎性结节组(P<0.05)。结果提示,肺内炎性结节的强化程度最高,其次是肺癌,胸腺瘤的强化程度很小。我们还发现,肺癌组 SS、BP 明显小于肺部炎性结节组(P<0.05);肺癌组 SS、BP 明显大于胸腺瘤组(P<0.05);胸腺瘤组 SS、BP 明显小于肺部炎性结节组(P<0.05)。结果提示,三组患者的血流灌注速度肺内炎性结节>肺癌>胸腺瘤,可能由于炎症结节内毛细血管扩张,血流速度快,而肺癌的灌注速度与氧气的供应和血管的舒张度有关,胸腺瘤内很少血液供应,因此灌注最少。

综上所述,螺旋 CT 动态增强扫描能够反映直径 3 厘米以上周围型肺癌的血流动力学特点,在肺癌的诊断和鉴别诊断方面具有较高的临床价值。

参考文献(References)

- [1] Liu S, Xiao X, Li C. Difference of microvessel structure between benign and malignant solitary pulmonary nodules and its relationship with CT enhancement level[J]. Chinese journal of lung cancer, 2013, 6 (1): 8-12
- [2] Shirasaka T, Funama Y, Hayashi M. Reduction of the unnecessary dose from the over-range area with a spiral dynamic z-collimator:

comparison of beam pitch and detector coverage with 128-detector row CT[J]. Radiological physics and technology, 2012, 5(1): 53-58

- [3] Sun H, Gao F, Li N. An evaluation of the feasibility of assessment of volume perfusion for the whole lung by 128-slice spiral CT [J]. Acta radiologica, 2013, 54(8): 921-927
- [4] Cherniavskii AM, Aliapkina EM, Terekhov IN. Dynamics of lung perfusion after pulmonary thromboendarterectomy in patients with chronic postembolic pulmonary hypertension [J]. Angiologiya i sosudistaya khirurgiya, 2013, 19(1): 118-123
- [5] Yi J, Wu XS, Crites T. Actin retrograde flow and actomyosin II arc contraction drive receptor cluster dynamics at the immunological synapse in Jurkat T cells [J]. Molecular biology of the cell, 2012, 23 (5): 834-852
- [6] Chamoto K, Gibney BC, Ackermann M. Alveolar macrophage dynamics in murine lung regeneration [J]. Journal of cellular physiology, 2012, 227(9): 3208-3215
- [7] Lu L, Zhang LJ, Poon CS, et al. Digital subtraction CT angiography for detection of intracranial aneurysms: comparison with three-dimensional digital subtraction angiography [J]. Radiology, 2012, 262(2): 613-622
- [8] Ari Han, Dae Young Yoon, Eun Soo Kim, et al. Value of CT angiography for the detection of intracranial vascular lesions in patients with acute severe headache[J]. European Radiology, 2013, 23 (6): 1443-1449
- [9] Du XL, Sheng XG, Jiang T, et al. Intensity-modulated radiation therapy versus para-aortic field radiotherapy to treat para-aortic lymph node metastasis in cervical cancer: prospective study[J]. Croat Med J, 2010, 51(3): 223-236
- [10] Sapey E, Stockley JA, Greenwood H. Behavioral and structural differences in migrating peripheral neutrophils from patients with chronic obstructive pulmonary disease [J]. American journal of respiratory and critical care medicine, 2011, 183(9): 1176-1186
- [11] Meehan AC, Sullivan LC, Mifsud NA. Natural killer cell activation in the lung allograft early posttransplantation [J]. Transplantation, 2010, 89(6): 756-763
- [12] Bajaj N, Bozarth AL, Guillot J, et al. Clinical features in patients with pulmonary embolism at a community hospital: analysis of 4 years of data[J]. J Thromb Thrombolysis, 2014, 37(3): 287-292
- [13] 金琼英, 胡红杰, 陈彬, 等. 恶性肿瘤合并肺栓塞的 CT 肺动脉造影及临床表现分析[J]. 实用放射学杂志, 2012, 28(6): 869-872
- Jin Qiong-ying, Hu Hong-jie, Chen Bin, et al. Pulmonary embolism complicated malignant tumors: CT pulmonary angiography and clinical analysis[J]. Journal of Practical Radiology, 2012, 28(6): 869-872

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- [3] Han B, Liang S, Jing Y. Organ preservation for muscle-invasive bladder cancer by preoperative intra-arterial chemotherapy and transurethral resection[J]. *Med Oncol*, 2014, 31(4): 912
- [4] Porena M, Del Zingaro M, Lazzeri M, et al. Bacillus Calmette-Guérin versus gemcitabine for intravesical therapy in high-risk superficial bladder cancer: a randomised prospective study[J]. *Urol Int*, 2010, 84(1): 23-27
- [5] 李奋勇, 李威武. 浅表性膀胱肿瘤术后卡介苗、丝裂霉素、吡柔吡星膀胱灌注疗效及副作用的临床观察[J]. *宁夏医学院学报*, 2007, 29(6): 586-588
Li Fen-yong, Li Wei-wu. The Clinical Investigation for the Efficacy and Safety of Intravesical Instillation of BCG, MMC and THP after TUR-Bt [J]. *Journal of Ningxia Medical College*, 2007, 29(6): 586-588
- [6] Suriano F, Altobelli E, Sergi F. Bladder cancer after radiotherapy for prostate cancer[J]. *Rev Urol*, 2013, 15(3): 108-112
- [7] Qin X, Wu K, Xie L. Reduced dose of Bacillus Calmette-Guerin versus full dose of Bacillus Calmette-Guerin for non-muscle-invasive bladder cancer after transurethral resection bladder tumor: a meta-analysis of randomized controlled trials [J]. *Chin Med J (Engl)*, 2014, 127(22): 3970-3974
- [8] Li J, Wang Q, Xiao B. Effect of internal iliac artery chemotherapy after transurethral resection of bladder tumor for muscle invasive bladder cancer[J]. *Chin J Cancer Res*, 2014, 26(5): 558-563
- [9] Jancke G, Rosell J, Jahnson S. Residual tumour in the marginal resection? after a complete transurethral resection is associated with local recurrence in Ta/T1 urinary bladder cancer [J]. *Scand J Urol Nephrol*, 2012, 46(5): 343-347
- [10] Fu WJ, Hong BF, Yang Y, et al. Two micron continuous wave laser vaporessection for the treatment of benign prostatic hyperplasia [J]. *Asian J Androl*, 2008, 10(2): 341-342
- [11] Sun DC, Yang Y, Wei ZT, et al. Transurethral dividing vaporessection for the treatment of large volume benign prostatic hyperplasia using 2 micron continuous wave laser[J]. *Chin Med J (Engl)*, 2010, 123(17): 2370-2374
- [12] Grossman HB, O'Donnell MA, Cookson MS, et al. Bacillus calmette-guérin failures and beyond: contemporary management of non-muscle-invasive bladder cancer[J]. *Rev Urol*, 2008, 10(4): 281-289
- [13] Wei ZT, Yang Y, Sun DC, et al. Transurethral partial cystectomy with a 2 micron laser in diagnosis and treatment for bladder submucosal lesions in adults [J]. *Chinese Journal of Surgery*, 2012, 50(4): 349-352
- [14] Moibi JA, Mak AL, Sun B, et al. Urothelial cancer cell response to combination therapy of gemcitabine and TRAIL[J]. *Int J Oncol*, 2011, 39(1): 61-71
- [15] Guo R, Zheng Y, Yang J. Association of TNF-alpha, IL-6 and IL-1beta gene polymorphisms with polycystic ovary syndrome: a meta-analysis[J]. *BMC Genet*, 2015, 16(1): 5
- [16] Tomaszewski JJ, Smaldone MC. Emerging intravesical therapies for management of nonmuscle invasive bladder cancer[J]. *Open Access J Urol*, 2010, 2: 67-84
- [17] Zhong C, Guo S, Tang Y, et al. Clinical observation on 2 micron laser for non-muscle-invasive bladder tumor treatment: single-center experience[J]. *World J Urol*, 2010, 28(2): 157-161
- [18] Smaldone MC, Gayed BA, Tomaszewski JJ, et al. Strategies to enhance the efficacy of intravesical therapy for non-muscle invasive bladder cancer[J]. *Minerva Urol Nefrol*, 2009, 61(2): 71-89
- [19] Liu H, Wu J, Xue S, et al. Comparison of the safety and efficacy of conventional monopolar and 2-micron laser transurethral resection in the management of multiple nonmuscle-invasive bladder cancer[J]. *J Int Med Res*, 2013, 41(4): 984-992
- [20] Guo G, Yang Y, Hong BF, et al. Histopathologic analysis of 2 micron continuous wave laser for the partial cystectomy of bladder urothelial carcinoma[J]. *Chinese Journal of Surgery*, 2009, 47(20): 1566-1568

(上接第 3519 页)

- [14] A Jadidi, H Lehrmann, C.I Park, et al. Nine-fold reduction in X-ray time & dose by optimized fluoroscopy and 3-D visualisation techniques during pulmonary vein ablation [J]. *Ann Thorac Surg*, 2012, 94: 1307-1310
- [15] Z. Jamil, G. Tearney, N. Bruining, et al. Interstudy reproducibility of the second generation, Fourier domain optical coherence tomography in patients with coronary artery disease and comparison with intravascular ultrasound: a study applying automated contour detection[J]. *Int J Cardiovasc Imaging*, 2013, 29(1): 39-51
- [16] Pratap Chandra Rath, Krupal Reddy, Manoj K, et al. Optical coherence tomography guided PCI Initial experience at Apollo Health City, Jubilee Hills, Hyderabad[J]. *Indian Heart J*, 2014, 66(1): 31-37
- [17] Gorenek B, Parspur A, Timuralp B, et al. Pulmonary vein ostium shape and orientation as possible predictors of occlusion in patients with drug-refractory paroxysmal atrial fibrillation undergoing cryoballoon ablation[J]. *Europace*, 2011, 13: 205-212
- [18] 刘士远, 于红. 积极推进胸部低剂量 CT 扫描的临床应用 [J]. *中华放射学杂志*, 2010, 44(1): 6-7
Liu Shi-yuan, Yu Hong. Actively promote the clinical application of chest low-dose CT scan[J]. *Chin J Radiol*, 2010, 44(1): 6-7
- [19] Söderberg M, Gunnarsson M. Automatic exposure control in computed tomography - an evaluation of systems from different manufacturers[J]. *Acta Radiologica*, 2010, 51(6): 625-634
- [20] Shaofeng Ma, Peng Wang. Three dimensional conformal radiotherapy III stage non-small cell lung cancer with lung function radioactive pneumonia clinical observation [J]. *Journal of clinical lung*, 2009, 14(2): 199-202