

· 专题研究:肿瘤 ·

基于CT上肿瘤-胸膜位置关系预测肺腺癌患者隐匿性纵隔淋巴结转移的临床价值

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[摘要] 目的: 基于肺腺癌原发灶的临床及影像学特征构建肺腺癌隐匿性纵隔淋巴结转移的预测模型。方法: 回顾性分析南京医科大学第一附属医院2009—2019年行手术治疗和淋巴结清扫、病理结果为有/无隐匿性纵隔淋巴结转移的肺腺癌患者, 收集患者的多个临床及影像学特征。采用单因素和多因素Logistic回归分析筛选独立预测因子, 并构建多个CT特征的影像模型。建立受试者工作特征(receiver operating characteristic, ROC)曲线评估各模型的预测效能和临床实用价值。结果: 在最终纳入的780例肺腺癌伴大小正常的淋巴结患者中, 145例发生淋巴结转移。单因素分析结果提示, 肿瘤大小、轴向位置、结节性质、形态学特征、胸膜牵拉征、胸膜毗邻类型与淋巴结转移显著相关。多因素分析结果提示, 肿瘤大小(OR=1.019, 95%CI: 1.002~1.036, $P=0.028$)、结节性质(OR=0.361, 95%CI: 0.202~0.646, $P=0.001$)、胸膜牵拉(OR=1.835, 95%CI: 1.152~2.924, $P=0.011$)和纵隔胸膜毗邻(OR=1.796, 95%CI: 1.106~2.919, $P=0.018$)是隐匿性纵隔淋巴结转移的独立预测因子。基于预测因子建立的影像学模型, ROC曲线下面积(area under the curve, AUC)为0.75, 灵敏度为86.2%, 特异度为53.1%。结论: 基于胸部CT平扫建立的影像学特征模型, 在预测肺腺癌隐匿性纵隔淋巴结转移上具有较好的临床价值, 可为临床医生的无创性术前决策及手术治疗方案选择提供依据。

[关键词] 肺腺癌; 肿瘤-胸膜关系; 隐匿性纵隔淋巴结转移

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The clinical value of imaging model based on tumor - pleura relationship on CT for predicting occult mediastinal lymph node metastasis in lung adenocarcinoma

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[Abstract] **Objective:** To construct a predictive model for occult mediastinal lymph node metastasis in lung adenocarcinoma based on clinical and imaging features of the primary tumor. **Methods:** A retrospective analysis was conducted on lung adenocarcinoma patients, who underwent surgical treatment and lymph node dissection with or without occult mediastinal lymph node metastasis on pathology at the First Affiliated Hospital of Nanjing Medical University from 2009 to 2019. Multiple clinical and imaging features of the patient were collected. Univariate and multivariate logistic regression analyses were used to identify independent predictors, and an imaging model incorporating multiple CT characteristics was constructed. Receiver operating characteristic (ROC) curves were established to evaluate the predictive efficacy and clinical utility value of each model. **Results:** Among the final 780 patients with normal-sized lymph nodes, 145 cases exhibited lymph node metastasis. Univariate analysis suggested that tumor size, axial location, nodule characteristics, morphological features, pleural pulling sign, and type of pleural adjacency were significantly associated with lymph node metastasis. Multivariate analysis indicated that tumor size (OR=1.019, 95% CI: 1.002–1.036, $P=0.028$), nodule characteristics (OR=0.361, 95% CI: 0.202–0.646, $P=0.001$), pleural tag (OR=1.835, 95%CI: 1.152–2.924, $P=0.011$), and presence of mediastinal pleural abutting (OR=1.796, 95% CI: 1.106–2.919, $P=0.018$) were independent predictors of occult mediastinal lymph

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node metastasis. The imaging model developed based on these predictors showed an area under the curve (AUC) of 0.75, with a sensitivity of 86.2% and specificity of 53.1%. **Conclusion:** The imaging model based on chest CT scans demonstrates excellent clinical value in predicting occult mediastinal lymph node metastasis in lung adenocarcinoma. It provides a basis for non-invasive preoperative decision making and surgical treatment planning by clinicians.

[Key words] lung adenocarcinoma; tumour-pleura relationship; occult mediastinal lymph node metastasis

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肺癌是世界范围内癌症相关死亡的最常见原因,也是我国最常见的恶性肿瘤^[1]。肺癌分小细胞肺癌(small cell lung carcinoma, SCLC)和非小细胞肺癌(non-small cell lung cancer, NSCLC),其中肺腺癌是非小细胞肺癌的主要组织学亚型^[2]。随着高分辨率CT的普及,肺结节检出率逐步提高,越来越多的早期肺癌患者可从手术切除获益^[3]。淋巴结转移是影响肺癌预后的主要因素之一^[4],显著降低了肺癌患者的生存率。目前,早期NSCLC的标准治疗方法仍然是肺叶切除术联合系统性淋巴结(systematic lymph nodes dissection, SLND)清扫^[5]。若术前发现有纵隔淋巴结受累,仅靠手术治疗的疗效有限。因此,准确的术前N分期可以帮助临床医生判断NSCLC患者最佳的治疗方式。

目前诊断术前淋巴结转移的方式主要有CT、正电子发射断层成像/X线计算机体层成像(positron emission tomography/computed tomography, PET/CT)、纵隔镜检查 and 支气管内超声引导下的经支气管针穿刺活检。18-氟脱氧葡萄糖正电子发射断层成像/X线计算机体层成像(¹⁸F-PET/CT)在NSCLC的淋巴结分期中起着重要作用,对检测肺门和纵隔淋巴结转移具有较高的敏感性。然而,由于肺癌患者常常伴有急慢性的肺部炎症,18-氟脱氧葡萄糖被感染性的淋巴结摄取表现为高摄取,造成假阳性^[6]。纵隔镜检查 and 超声引导下的经支气管针穿刺活检(endobronchial ultrasound guided transbronchial needle aspiration, EBUS-guided TBNA)准确率较高^[7-8],但由于临床手术的困难和检查的侵入性,患者术中及术后易合并气胸、出血及呼吸障碍等并发症^[8]。除了有限数量的临床报告外,以往的研究大多集中在淋巴结本身的病理特征上,CT特征并不是主要的研究对象。通常所有患者在术前都要进行胸部CT检查以明确肺癌治疗前诊断和分期^[9]。由于存在正常大小的转移性淋巴结和良性的肿大淋巴结,仅以CT上淋巴结的短径大小为标准来判定淋巴结有无转移具有局限性^[10]。因此,探究新的可靠的影像学特征

来预测肺腺癌的隐匿性淋巴结转移至关重要。既往部分研究评估了原发灶与隐匿性淋巴结转移之间的临床及影像特征的相关性,其中组织学类型、血清癌胚抗原(carcinoembryonic antigen, CEA)水平、病理胸膜浸润和淋巴管浸润等因素被确定为预测隐匿性淋巴结转移的重要危险因素^[11]。另外,根据Zhang等^[12]研究结果显示,具有微乳头成分的肺腺癌患者发生淋巴结转移的风险较无微乳头成分的患者高一倍。这些研究表明,将肿瘤的临床病理等特征与CT特征相结合,有助于预测NSCLC患者的隐匿性淋巴结转移;但这些研究纳入资料有限,缺乏肿瘤形态学特征及肿瘤-胸膜的位置特征;另外,Zhang等^[12]研究中纳入了术后病理,而术后病理结果不能作为术前预测的有效手段,并且无法较好地体现影像学无创性预测的特点。

综上所述,本研究的目的是基于患者临床及影像学特征,尤其是肺癌原发灶与胸膜之间的关系,构建肺腺癌隐匿性纵隔淋巴结转移的最佳预测模型,以期为外科医生提供更多信息,帮助其选择最佳治疗方案,避免不必要的淋巴结清扫。

1 对象和方法

1.1 对象

回顾性分析南京医科大学第一附属医院2009年7月—2019年6月行手术治疗,病理结果为有/无隐匿性纵隔淋巴结转移的肺腺癌患者。在最终纳入的2287例患者中,780例淋巴结大小正常的肺腺癌患者分别接受了肺叶切除($n=751$)、节段切除($n=16$)或楔形切除($n=13$)。纳入标准:①行根治性手术治疗(完整切除病灶,并联合系统性淋巴结清扫),术后病理证实为肺腺癌;②临床信息完整,术前1个月接受CT扫描(平扫/增强);③CT上无肺门或纵隔淋巴结肿大(轴向图像上定义为短轴直径 ≥ 10 mm),临床诊断无淋巴结转移(N0)。排除标准:①未经系统性淋巴结清扫;②合并其他恶性肿瘤;③患者术前接受过放疗;④临床及影像学资料不完整。

2位病理医师确认患者术后的组织病理学类型,根据第8版肺癌TNM分型确定肿瘤N分期^[13]。根据国际肺癌研究协会(International Association for the Study of Lung Cancer, IASLC)标准,系统性淋巴结清扫定义为右侧常规探查清扫纵隔2R、4R、7、9组淋巴结和肺门10、11组淋巴结,左侧常规探查清扫纵隔5、6、7、9组淋巴结和肺门10、11组淋巴结^[14]。本研究得到了南京医科大学第一附属医院伦理委员会的批准(2018-SRFA-139)。

1.2 方法

1.2.1 检查

胸部CT检查采用Siemens Somation Definition 64排CT扫描仪进行,患者取仰卧位,行横断面螺旋CT扫描。扫描范围:肺尖至膈底,包括两侧肋膈角。扫描参数:管电压120 kV,管电流100 mAs。B40重建算法的间隔为5 mm,无间隙;B70重建算法的间隔为1.5 mm,无间隙。平扫结束后,使用动力注射器静脉注射80~100 mL非离子型对比剂(碘丙胺300,300 mgI/mL)和40 mL生理盐水后,延迟40 s获得增强CT图像。所有图像均在纵隔窗(窗宽350 HU,窗位50 HU)和肺窗(窗宽1 200 HU,窗位-600 HU)的轴位图像上进行测量。

1.2.2 影像学资料

CT特征采集如下:①肿瘤大小(长直径);②轴向位置(周围型和中央型);③肺叶解剖位置(左肺上叶、左肺下叶、右肺上叶、右肺中叶、右肺下叶);④结节性质[纯磨玻璃(ground glass opacity, GGO)、GGO为主、实性为主、纯实性];⑤形态学特征(分叶征、毛刺征、边界清楚);⑥胸膜牵拉征(胸膜牵拉被定义为从结节表面向胸膜延伸的线性标签)^[15];⑦胸膜毗邻(胸膜毗邻被定义为肿瘤与周围胸膜结构保持连续接触,如纵隔胸膜、脏层胸膜和叶间胸膜,并在术前CT上表现为沿肺边界有超过1个附着点),根据结节位置分为纵隔和非纵隔胸膜(脏层胸膜或叶间胸膜)毗邻^[16]。

由2名放射科医师(分别有5年和4年的胸部放射学诊断经验)对CT图像进行一致性评价,任何差异均由另1位高年资的放射科医生(20年的胸部放射学诊断经验)进行核对。

1.3 统计学方法

使用SPSS26.0进行统计分析。对所有数据进行正态性检验,符合正态分布的连续变量以均数±标准差($\bar{x} \pm s$)表示,组间比较采用独立样本 t 检验;分类变量以频数或百分比表示,采用卡方检验或

Fisher精确检验。对单因素分析中 $P < 0.10$ 的协变量纳入多因素Logistic回归分析。多因素Logistic回归分析确定纵隔淋巴结转移的独立危险因素,并构建影像特征模型的受试者工作特征(receiver operating characteristic, ROC)曲线,并计算曲线下面积(area under the curve, AUC)、灵敏度、特异度以评价模型的诊断性能,与单个危险因素模型进行比较。采用DeLong检验比较模型间AUC是否具有统计学意义。采用Kappa相关系数评估观察者间对肿瘤大小、结节性质、形态学特征、胸膜牵拉征和胸膜毗邻评价的一致性。皮尔逊相关系数用于评估肿瘤大小的观察者之间的相关性。 $P < 0.05$ 为差异有统计学意义。

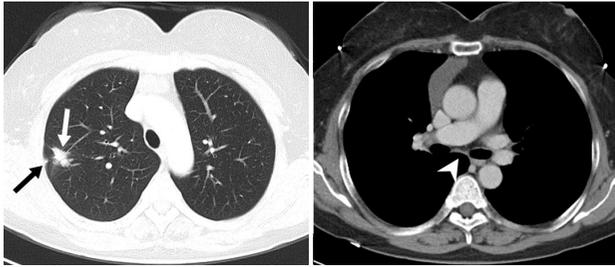
2 结果

2.1 一般资料

780例肺腺癌患者无淋巴结转移635例,有淋巴结转移145例。患者年龄为(61.8±10.0)岁,男436例(55.9%),女344例(44.1%)。大多数肿瘤经病理证实为N0期($n=531$,占68.1%),其余为N1期($n=104$,占13.3%)和N2期($n=145$,占18.6%)。肿瘤组织高分化226例(29.0%),中分化419例(53.7%),低分化135例(17.3%)。249例(31.9%)患者有纵隔淋巴结转移,其中pN1期104例(13.3%),pN2期145例(18.6%)。所有肿瘤的直径为(31.0±13.9)mm,观察者对肿瘤大小的评价一致性良好($\kappa=0.61$)。右上肺叶($n=238$,30.5%)是最常见的肺叶位置。肿瘤大部分位于肺外周($n=623$,79.9%)。大多数肿瘤为部分实性或纯实性($n=496$,63.6%),且具有分叶征($n=643$,82.4%)。529例(67.8%)患者存在胸膜牵拉(图1)。在780例患者中,有174例(22.3%)和451例(57.8%)患者分别贴近纵隔胸膜和非纵隔(脏层/叶间)胸膜(图2)。所有CT特征(κ 范围:0.55~0.95)在观察者间一致性较好。

2.2 单因素和多因素分析

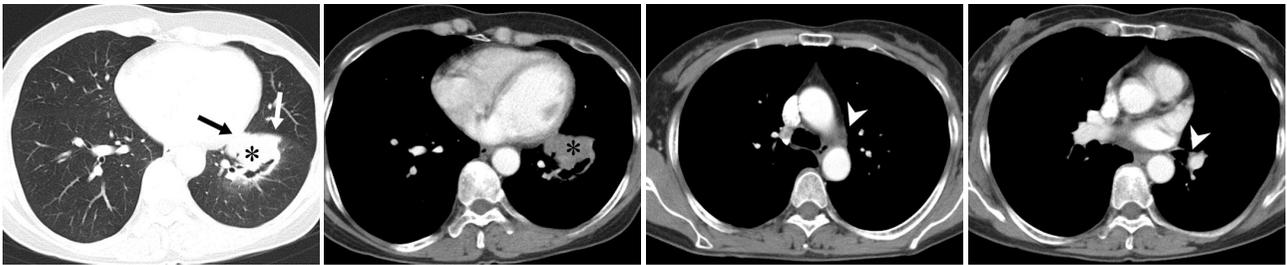
单因素分析显示,肿瘤大小、轴向位置、结节性质、形态学特征、胸膜牵拉征、胸膜毗邻类型与淋巴结转移显著相关(表1)。在本研究中,根据第8版的TNM分期,T1期、T2期和T3期的纵隔淋巴结转移率分别为11.8%、24.4%和34.5%。单纯GGO肿瘤患者均未发生淋巴结转移。1例部分GGO肿瘤患者为pN1期。16例部分实性(10.5%)患者和129例纯实性(26.0%)患者有病理性纵隔淋巴结受累。纵隔胸膜和非纵隔胸膜毗邻的患者中,分别有56例



The case of a 62-year-old woman with lung adenocarcinoma in the right upper lobe. Contrast-enhanced CT images were acquired in the axial plane using a lung window setting with a 5 mm slice thickness, revealing a 1.6 cm solid, lobulated nodule (indicated by a white arrow) accompanied by a pleural tag (marked by a black arrow). Although the subcarinal lymph node (denoted by a white arrowhead) appeared normal in size on CT imaging, subsequent pathological examination confirmed the presence of metastatic involvement.

图1 女62岁右肺上叶肺腺癌

Figure 1 A 62 years-old woman lung adenocarcinoma



The case of a 58-year-old woman with lung adenocarcinoma in the left upper lobe. Contrast-enhanced CT images were acquired in both axial and coronal planes using lung and mediastinal window settings at 5 mm slice thickness. These images demonstrate a 4.4 cm solid, lobulated mass (*) with evidence of abutment to the mediastinal and interlobar pleura (indicated by black and white arrows). While the subaortic, hilar, and interlobar lymph nodes (marked by white arrowheads) exhibited normal dimensions on CT imaging, pathological evaluation subsequently confirmed metastatic involvement in these nodal stations.

图2 女58岁左肺上叶肺腺癌

Figure 2 A 58 years-old woman with lung adenocarcinoma

邻) AUC 为 0.751, 灵敏度为 86.2%, 特异度为 53.1%, 其 AUC 值高于其余单一因素所建立的模型。虽然以结节性质所建立的模型灵敏度较高(89.0%), 但其特异度较低(42.2%), 而以肿瘤与纵隔胸膜相邻所建立的模型特异度较高(81.4%), 其灵敏度较低(38.6%), 最终以多个影像特征所建立的模型更能准确预测淋巴结隐匿性转移。

3 讨论

近年来, 有研究认为对于无淋巴结转移的早期 NSCLC 患者, 可对其行楔形切除、肺节段切除等有限切除^[17], 与标准手术相比, 可以保留更多的功能性肺组织, 降低围手术期病死率。而对于有限的手术, 最重要的是需要准确的淋巴结分期来确认其阴

(32.2%) 和 101 例 (26.3%) 发现淋巴结转移, 而在 258 例所有类型胸膜均不毗邻的患者中, 只有 24 例 (0.9%) 患者有淋巴结转移。

临床放射学特征的多变量 Logistic 回归显示, 肿瘤大小 (OR=1.019, 95% CI: 1.002~1.036, P=0.028)、结节性质 (OR=0.361, 95% CI: 0.202~0.646, P=0.001)、胸膜牵拉 (OR=1.835, 95% CI: 1.152~2.924, P=0.011) 和有纵隔胸膜毗邻 (OR=1.796, 95% CI: 1.106~2.919, P=0.018) 是隐匿性纵隔淋巴结转移的显著独立预测因子(表 2)。

2.3 影像特征预测模型

根据以上特征, 分别采用多因素 Logistics 回归构建预测模型, 建立 ROC 曲线(图 3), 模型各项指标见表 3。其中以多个 CT 特征所建立的影像模型(包括肿瘤大小、结节性质、有胸膜牵拉和纵隔胸膜毗

性状态。本研究考察了原发性肺癌的 CT 特征, 发现较大的肿瘤、纯实性肿瘤、存在胸膜牵拉和与纵隔胸膜毗邻是肺腺癌患者纵隔淋巴结转移具有统计学意义的预测因素。

既往一些研究表明, 淋巴结转移的可能性随着肿瘤大小的增加而增加^[18]。在本研究中, 术前原发肿瘤大小是纵隔淋巴结转移的一个重要预测因素。这与之前的研究结果一致。此外, 其他一些研究提到, <2 cm 的肺癌较少发生纵隔淋巴结转移^[19]。在本研究中, 有 5.9% 的直径 <2 cm 的肺腺癌患者有隐匿的纵隔淋巴结转移。虽然这部分肿瘤直径较小且较少出现淋巴结转移, 但仍存在纵隔淋巴结转移的风险。JCOG0802 研究提示, 对于外周型的长径 ≤ 2 cm、CT 上实性成分占比 (consolidation tumor ratio,

表1 肺腺癌患者CT特征与隐匿性纵隔淋巴结转移关系的单因素分析

Table 1 Univariate analysis of the relationships between CT characteristics and occult mediastinal lymph node metastasis in patients with lung adenocarcinoma

Characteristic	Total	Lymph node metastasis		Univariate analysis <i>P</i>
		Negative(<i>n</i> =635)	Positive(<i>n</i> =145)	
Size(mm, $\bar{x} \pm s$)	31.0 ± 13.9	27.9 ± 13.2	37.5 ± 13.4	<0.001
Lobar location[<i>n</i> (%)]				0.110
Right upper lobe	238(30.5)	200(31.5)	38(26.2)	
Right middle lobe	54(6.9)	43(6.8)	11(7.6)	
Right lower lobe	146(18.7)	116(18.3)	30(20.7)	
Left upper lobe	183(23.5)	139(21.9)	44(30.3)	
Left lower lobe	159(20.4)	137(21.6)	22(15.2)	
Axial location[<i>n</i> (%)]				0.007
Peripheral	623(79.9)	519(81.7)	104(71.7)	
Central	157(20.1)	116(18.3)	41(28.3)	
Contour[<i>n</i> (%)]				0.026
Circumscribed	17(2.2)	17(2.7)	0(0)	
Lobulated	643(82.4)	519(81.7)	124(85.5)	
Spiculated	120(15.4)	99(15.6)	21(14.5)	
Opacity[<i>n</i> (%)]				<0.001
Pure GGO	44(5.6)	44(6.9)	0(0)	
GGO predominant	87(11.2)	87(13.7)	0(0)	
Solid predominant	153(19.6)	137(21.6)	16(11.0)	
Pure solid	496(63.6)	367(57.8)	129(89.0)	
Pleural tag[<i>n</i> (%)]				0.004
Absence	251(32.2)	219(34.5)	32(22.1)	
Presence	529(67.8)	416(65.5)	113(77.9)	
Mediastinal pleura abutting[<i>n</i> (%)]				<0.001
Absence	606(77.7)	517(81.4)	89(61.4)	
Presence	174(22.3)	118(18.6)	56(38.6)	
Non-mediastinal pleura abutting[<i>n</i> (%)]				0.001
Absence	329(42.2)	285(44.9)	44(30.3)	
Presence	451(57.8)	350(55.1)	101(69.7)	

CTR)>0.5的NSCLC,肺段切除与肺叶切除无复发生存率差异无统计学意义,肺段切除的总生存优于肺叶切除,但是肺段切除局部复发率高于肺叶切除。对于这类结节,肺段切除在保留肺功能及生存率上是否优于肺叶切除,仍需其他前瞻性临床试验结果证实^[20]。

由于高分辨率CT的普及,检测早期表现为GGO型肺癌的机会有所增加。含有磨玻璃成分的肺癌通常被证实是一种早期肺癌,如原位腺癌或微浸润性腺癌。因此,外科医生经常考虑将楔形切除或肺段切除作为其手术的一种选择^[21]。Lin等^[22]研究提示以GGO成分为主的IA期腺癌无淋巴结转移。GGO的比例可能是肿瘤具有侵袭性的一个强

有力预测因子,并可能是有限手术切除的一个重要指标。本研究显示在133例GGO成分为主肺癌患者中,只有1例(0.8%)pN1期患者,而44例纯GGO的患者均无淋巴结转移。基于此研究结果,本研究认为对于含GGO成分的早期腺癌,特别是纯GGO的肿瘤,淋巴结转移较为罕见,提示在术中可不必进行淋巴结清扫,这也与姜格宁等^[23]关于早期肺腺癌的诊断和治疗共识一致。

胸膜牵拉征是帮助放射科医师区分恶性结节和良性结节的一个重要征象,然而它们也可以发生在其他肺部疾病过程中。病理上,胸膜牵拉是由肺小叶间隔增厚引起的,内脏胸膜和小叶间隔之间的解剖连续性导致胸膜表面收缩^[24]。在本研究中,有

表2 肺腺癌患者CT特征与隐匿性纵隔淋巴结转移关系的多因素分析

Table 2 Multivariate analysis of the relationships between CT Characteristics and occult mediastinal lymph node metastasis in patients with lung adenocarcinoma

CT Characteristic	Multivariate analysis		
	OR	95%CI	P
Size	1.019	1.002-1.036	0.028
Axial location			
Peripheral	1.000	-	-
Central	1.269	0.762-2.113	0.360
Contour			
Circumscribed	1.000	-	0.958
Lobulated	0.000	-	0.998
Spiculated	0.920	0.528-1.605	0.770
Opacity			
Pure GGO	0.000	-	0.996
GGO predominant	0.000	-	0.997
Solid predominant	0.361	0.202-0.646	0.001
Pure solid	1.000	-	0.008
Pleural tag			
Absence	1.000	-	-
Presence	1.835	1.152-2.924	0.011
Mediastinal pleura abutting			
Absence	1.000	-	-
Presence	1.796	1.106-2.919	0.018
Non-mediastinal pleura abutting			
Absence	1.000	-	-
Presence	1.348	0.872-2.082	0.179

67.8%的腺癌有胸膜牵拉征,其中113例(21.4%)患者发生了淋巴结转移,并且胸膜牵拉征也被确定为纵隔淋巴结转移的一个独立预测因子。Hsu等^[25]研究也表明1个或多个具有软组织成分的线性胸膜连接可以提高NSCLC早期诊断内脏胸膜侵犯的准确性。这可能是由于有胸膜牵拉导致胸膜凹陷的肺腺癌中内脏胸膜浸润比例高,肿瘤细胞通过内脏胸膜中的淋巴管引流至纵隔淋巴结。

与其他研究相比,本研究探究了肿瘤所在位置(是否毗邻纵隔胸膜)与淋巴结转移之间的关系,并证实纵隔胸膜毗邻的肿瘤有更高的隐匿性淋巴结转移的风险。先前研究表明通过病理诊断的内脏胸膜侵犯(visceral pleural invasion, VPI)是NSCLC的一个重要预后因素,影响肿瘤分期、手术方式和治疗方式。胸膜牵拉征、肿瘤与胸膜接触的长度和肿瘤-胸膜的距离已被确认为VPI的潜在指征^[26-27]。

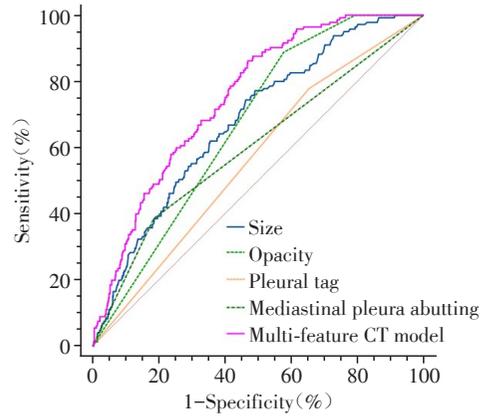


图3 模型的评价和比较

Figure 3 Evaluation and comparison of the developed models

表3 不同模型的预测效能

Model	AUC(95%CI)	SEN (%)	SPE (%)
Size	0.667(0.633-0.700)	74.5	53.7
Opacity	0.678(0.644-0.711)	89.0	42.2
Pleural tag	0.562(0.526-0.597)	77.9	34.5
Mediastinal pleura abutting	0.600(0.565-0.635)	38.6	81.4
Multi-feature CT model	0.751(0.719-0.781)	86.2	53.0

AUC: area under the curve; SEN: sensitivity; SPE: specificity.

Zhang等^[28]将肿瘤与胸膜关系分为4类,并提出3型(即肿瘤与胸膜不接触,在胸膜端可见1个或多个带有软组织成分的线性或条状的胸膜标记)和4型(即肿瘤接触胸膜)的肿瘤-胸膜关系内脏胸膜侵犯比例高;若存在内脏胸膜浸润,肿瘤细胞易通过内脏胸膜中的淋巴管引流转移到纵隔淋巴结,因此VPI阳性患者比VPI阴性患者更可能发生淋巴结转移。据此本研究推测毗邻胸膜的肿瘤可能与更高的隐匿性淋巴结转移风险相关,并探究毗邻何种胸膜的肿瘤更易发生隐匿性淋巴结转移。本研究纵隔胸膜和非纵隔胸膜毗邻的患者中分别有32.2%和26.3%的患者发生纵隔淋巴结转移,相比之下,只有0.9%的所有类型胸膜均不毗邻的患者有淋巴结转移。虽然确切的原因尚不清楚,但肺的淋巴引流可能是导致纵隔胸膜相邻的患者淋巴结转移比例高的原因。肺的淋巴管是一个丰富的内脏胸膜网和支气管血管周围的神经丛,主要由位于气道周围的结缔组织及其支气管动脉血管供应。内脏胸膜淋巴收集器通过肺表面向肺门移动,在那里它们通常与支气管血管周围神经丛的淋巴收集器吻合^[29];因此,

纵隔胸膜淋巴网比非纵隔胸膜淋巴网要密集得多。本文推测与纵隔胸膜毗邻的肺腺癌有更多的机会转移到纵隔淋巴结,但还需进一步的调查研究来证实这些发现。

本研究也存在一定局限性。首先,这是一项基于单一三级医院数据的回顾性研究,可能存在选择偏倚。其次,CT征象的评价是主观的,可能会出现测量误差,特别是不规则的肿瘤大小和肿瘤的GGO比例。最后,本研究没有包括一些淋巴结特征,如PET上的大小和max-suv。然而,本研究关注的是利用原发性肺癌的CT特征来预测隐匿的纵隔淋巴结转移,而不是关注淋巴结特征本身。因此当遇到淋巴结自身特征模糊的患者时,本研究描述的肿瘤原发灶的其他影像学特征可能会有所帮助。

综上所述,研究表明体积大、实性成分肿瘤、存在胸膜牵拉和纵隔胸膜毗邻的肿瘤,有更高的隐匿性纵隔淋巴结转移的风险,并且据此所建立的影像特征模型有良好的预测效能。本研究所确定的隐匿性纵隔淋巴结转移的预测因素,将帮助胸外科医生在可切除的肺腺癌患者中选择更合适的治疗方案。

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郝沁敏负责实验设计、数据收集和初步分析,参与论文撰写;贾亦真数据收集、数据处理和统计分析,协助撰写论文;李海提供研究思路,指导数据分析;徐海提供研究思路,指导数据分析;俞同福提供研究思路,指导数据分析;袁梅负责研究的整体指导和论文的修改完善。

Author's Contributions:

HAO Qinmin was responsible for experimental design, data collection, and preliminary analysis, and also participated in writing the manuscript. JIA Yizhen handled data collection, data processing, and statistical analysis, and assisted in writing the manuscript. LI Hai provided research ideas and guided the data analysis. XU Hai also provided research ideas and guided the data analysis. YU Tongfu contributed research ideas and guided the data analysis. YUAN Mei was responsible for the overall guidance of the research and the revision and improvement of the manuscript.

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