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·临床研究·

术前三维重建联合荧光染色法在单孔胸腔镜肺段切除术中的应用

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[摘 要] **目的** 研究单孔胸腔镜肺段切除术患者术前应用三维重建联合荧光染色法的效果,旨在为单孔胸腔镜肺段切除术提供技术支持,改善患者预后。**方法** 纳入我院收治的66例肺结节患者,根据手术方法不同将患者分为对照组和观察组,每组33例。对照组患者采用传统膨胀萎陷法单孔胸腔镜肺段切除术治疗;观察组患者采用术前三维重建联合荧光染色法单孔胸腔镜肺段切除术治疗。观察2组患者手术情况、术后情况以及并发症发生情况。**结果** 观察组手术时间和段间交界面出现时间短于对照组,术中出血量少于对照组,差异均有统计学意义($P<0.05$);2组患者淋巴结清扫个数比较,差异无统计学意义($P>0.05$)。观察组术后拔管时间、术后住院时间短于对照组,总引流量少于对照组,差异均有统计学意义($P<0.05$)。观察组并发症发生率仅为6.06%,明显低于对照组的27.27%,差异有统计学意义($P<0.05$)。**结论** 应用术前三维重建联合荧光染色法进行单孔胸腔镜肺段切除术能快速、清晰地显示肺段间交界面,为手术提供技术支持,可缩短手术时间,减少术中出血量,安全性相对较高,值得临床应用及推广。

[关键词] 三维重建;荧光染色;单孔胸腔镜肺段切除术

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Application of preoperative three-dimensional reconstruction combined with fluorescence staining in single-port thoracoscopic segmentectomy

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Abstract: Objective To study the effect of preoperative three-dimensional reconstruction combined with fluorescence staining in patients undergoing single-port thoracoscopic segmentectomy, aiming to provide technical support for single-port thoracoscopic segmentectomy and improve the prognosis of patients. **Methods** A total of 66 patients with pulmonary nodules admitted to our hospital were included and divided into the control group and the observation group according to different surgical methods, with 33 cases in each group. Patients in the control group were treated with single-port thoracoscopic segmentectomy with conventional dilation and collapse method, patients in the observation group were treated with single-port thoracoscopic segmentectomy with preoperative three-dimensional reconstruction combined with fluorescence staining. The operation conditions, postoperative conditions and complications of the patients in the two groups were observed. **Results** The operation time and intersegmental interface display time in the observation group were shorter than those in the control group, the intraoperative bleeding volume was less than that in the control group, the differences were statistically significant ($P<0.05$); there was no statistically significant difference in the number of lymph node dissection between the two groups ($P>0.05$). The postoperative extubation time and postoperative hospital stay in the observation group were shorter than those in the control group, and the overall drainage volume was less than that in the control group, the differences were statistically significant ($P<0.05$). The incidence of complications in the observation group was only 6.06%, which was significantly lower than 27.27% in the control group, and the difference was statistically significant ($P<0.05$). **Conclusion** The application of preoperative three-dimensional reconstruction combined with fluorescence staining for single-port thoracoscopic segmentectomy can quickly and clearly display the intersegmental interface and provide the technical support for the operation, so as to shorten the operation time, reduce the intraoperative bleeding volume, and is relatively safe, which is worthy of clinical application and promotion.

Keywords: three-dimensional reconstruction; fluorescence staining; single-port thoracoscopic segmentectomy

随着影像学技术的发展,影像学越来越多地应用于临床疾病的诊断,其对于肺癌的检出率呈明显升高趋势。早期肺癌多表现为肺结节,如何精准切除肺结节是临床思考的重点问题[1]。肺段切除术是目前临床用于切除肺结节的手术方式之一,由于其可保留正常肺组织,对肺部损伤较小,已成为治疗早期肺癌的常用术式[2-3]。肺段之间并无明显解剖学界限,在肺段切除时如何区分需要切除以及需要保留的肺段是困扰术者的难题。以往临床常采用膨胀萎陷法进行段间交界面的判断,但肺部膨胀时容易遮挡手术视野,减少手术操作空间,给手术操作带来一定困难[4-5]。近年来,荧光染色显示肺段间交界面的方法被临床广泛应用,影像学三维重建技术的发展也为准确定位解剖学结构提

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供了便利[6-7]。然而目前临床上针对术前三维重建联合荧光染色技术的研究较少,尤其是对肺部手术更是鲜有研究。本研究对我院行单孔胸腔镜肺段切除术的患者采用术前三维重建联合荧光染色法,以期进一步提高肺段间交界面定位的准确性,改善患者预后。

1 资料与方法

1.1 临床资料

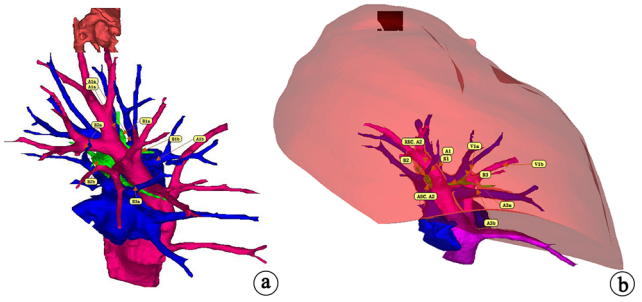
纳入2020年6月至2021年12月我院收治的肺结节患者66例。所有纳入患者符合肺段手术适应证:①解剖位置较深无法行肺楔形切除或者局限于某个肺段的良性病变;②周围型早期非小细胞肺癌,肿瘤直径≤2 cm;肿瘤恶性程度低(原位癌和微浸润腺癌)或磨玻璃成分≥50%;血肿瘤标志物正常。排除标准:①肿瘤出现远处转移;②有麻醉禁忌证;③精神异常无法配合研究;④同时参与其他研究。按手术方法不同分为对照组和观察组,每组33例。对照组患者采用传统膨胀萎陷法单孔胸腔镜肺段切除术治疗;观察组患者采用术前三维重建联合荧光染色法单孔胸腔镜肺段切除术治疗。对照组中,男15例,女18例;年龄38~75岁,平均(59.59±10.59)岁;体质量(60.80±13.27)kg,结节直径(13.24±2.93)mm。观察组中,男17例,女16例;年龄37~74岁,平均(58.39±9.91)岁;体质量(62.50±11.32)kg,结节直径(13.06±2.40)mm。2组患者性别、年龄、体质量、结节直径比较,差异无统计学意义($P>0.05$),具有可比性。本研究已通过我院医学伦理委员会审核,所有患者均签署手术知情同意书。

1.2 方法

1.2.1 手术方法 患者取健侧90°卧位,全身麻醉,双腔气管插管,于腋前线第5肋间作3 cm切口,置入切口保护套撑开肋间。根据手术肺段的不同及肺裂发育情况处理肺段动脉、静脉及支气管,处理原则为先易后难。处理靶段血管时根据血管粗细情况选择丝线结扎或腔镜下直线切割缝合器白钉仓处理,处理靶段支气管采用腔镜下直线切割缝合器金钉仓处理,必要时使用4-0可吸收线加缝支气管残端。膨胀萎陷法或荧光染色法确认段间交界面,腔镜下直线切割缝合器蓝钉仓、金钉仓、绿钉仓或超声刀联合处理进行肺段切除。切除组织送病理检查,根据快速病理结果选择患者淋巴结清除的范围。原位癌和微浸润腺癌则不切除淋巴结或淋巴结采样,浸润性癌行N1和N2淋巴结采样送检,若癌转移则改行肺叶切除和系统性淋巴结清扫,手术结束后切口放置引流管至胸顶。

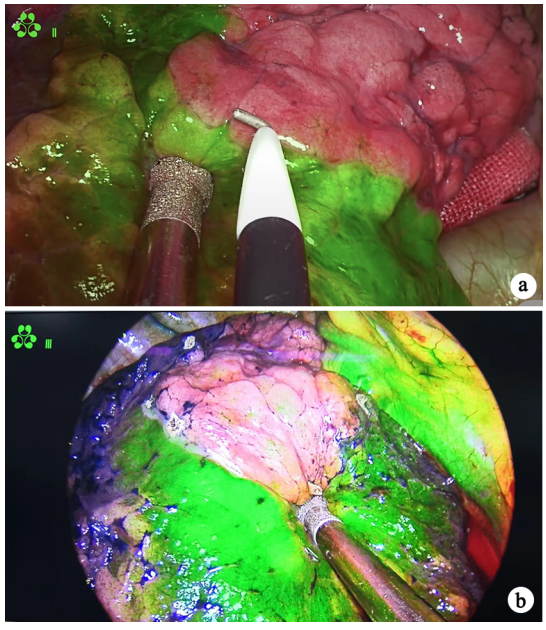
1.2.2 传统膨胀萎陷法(对照组) 术前仔细阅读增强CT扫描图象,了解肺部血管及支气管解剖结构特点。选择高清腔镜,切断靶段支气管、动静脉后,嘱咐麻醉医师重新完全膨胀全肺,再恢复健侧单肺通气,随后形成清晰且不再移位的膨胀萎陷交界线,电凝灼烧标记交界面,然后处理段间交界面完成肺段切除。

1.2.3 三维重建联合荧光染色法(观察组) 将DCM格式图像导入MIMICS 21.0系统进行三维重建,识别结节位置,并对支气管、动静脉等结构进行三维重建,在重建图形上标明需要切除以及需要保留的肺段所包含的支气管和动静脉,勾勒两者间的交界面(图1)。选择荧光胸腔镜,术中根据术前三维重建模型进行解剖性肺段手术。将模式调为荧光模式,嘱咐巡回护士将25 mg吲哚菁绿溶于10 mL生理盐水,取5 mL经外周静脉快速注入,电凝灼烧标记交界面(图2),然后处理段间交界面完成肺段切除。



a:右肺上叶动脉、静脉、支气管与病灶;b:右肺上叶尖段病灶三维重建图像

图1 术前右肺上叶三维重建图像



a:沿染色边界用电钩标记目标肺段;b:右肺上叶肺尖段吲哚菁绿荧光染色

图2 术中肺段荧光染色图片

1.3 观察指标

统计2组患者手术情况、术后情况及并发症发生

情况。手术情况包括手术时间、术中出血量、段间交界面出现时间以及淋巴结清扫个数。术后情况包括术后拔管时间、总引流量和术后住院时间。并发症包括肺部感染、胸腔积液、肺部漏气及下肢静脉血栓等。

1.4 统计学处理

采用SPSS 23.0统计软件分析数据。计量资料以均数±标准差($\bar{x}\pm s$)表示,采用t检验;计数资料以率(%)表示,采用χ^2检验。$P<0.05$为差异有统计学意义。

2 结果

2.1 患者手术情况比较

观察组手术时间和段间交界面出现时间短于对照组,术中出血量少于对照组,差异均有统计学意义($P<0.05$);2组患者淋巴结清扫个数比较差异无统计学意义($P>0.05$),见表1。

表1 患者手术情况比较($\bar{x}\pm s$,$n=33$)

组别	手术时间/min	术中出血量/mL	段间交界面出现时间/s	淋巴结清扫个数/个
对照组	116.24±25.71	96.59±22.47	947.36±288.49	7.14±1.65
观察组	102.08±20.62	67.36±17.85	24.69±4.43	7.22±1.68
t	2.468	5.851	18.371	0.195
P	0.016	<0.001	<0.001	0.846

2.2 患者术后情况比较

观察组术后拔管时间、术后住院时间短于对照组,总引流量少于对照组,差异均有统计学意义($P<0.05$),见表2。

表2 患者术后情况比较($\bar{x}\pm s$,$n=33$)

组别	术后拔管时间/d	总引流量/mL	术后住院时间/d
对照组	4.17±0.82	558.52±125.63	6.72±1.65
观察组	3.62±0.71	379.37±104.65	5.23±1.16
t	2.913	6.294	4.244
P	0.005	<0.001	<0.001

2.3 患者并发症发生情况比较

观察组并发症发生率仅为6.06%,明显低于对照组的27.27%,差异有统计学意义($P<0.05$),见表3。

表3 患者并发症发生情况比较[$n=33$,例(%)]

组别	肺部感染	胸腔积液	肺部漏气	下肢静脉血栓	总发生
对照组	5(15.15)	2(6.06)	1(3.03)	1(3.03)	9(27.27)
观察组	2(6.06)	0(0)	0(0)	0(0)	2(6.06)
χ^2					5.345
P					0.005

3 讨论

肺结节一般采用肺段切除术治疗效果较好,相对于肺叶切除术,肺段切除术能保留更多肺组织,肺损伤更小,手术精确性更高[8]。与楔形切除相比,肺段切除术能进行肺内淋巴结采样,可确保手术切缘的精准性,提高患者总体生存率[9]。但由于肺磨玻璃样结节与正常肺组织密度相似,仅凭胸腔镜进行判断较为困难[10],且支气管和肺动静脉间结构复杂,也为肺段切除术的实施带来了极大的困难[11]。

随着影像学的发展,三维重建技术的出现提高了CT扫描的精准度,通过三维重建绘制出3D立体图像,重建各个器官的形态,通过不同颜色区分肺部血管及支气管等结构,能360°旋转图形,从多个角度、层次对肺部进行观察,从而制定最佳手术计划,确定手术方案,提高手术精准度[12]。研究显示,通过三维重建技术,能在术前确定患者手术入路位置,规划手术方案,可提高手术的精准度,降低手术损伤率;另外,其还可通过不同色块辨认病灶与周围组织的界限,达到精准识别的目的[13]。在肺段切除术中,如何辨别需要保留的肺组织和靶段之间的交界一直是胸外科医生关注的重点。既往临床常采用膨胀萎陷法区分靶段与正常肺组织的界限,但耗时较长,效果并不理想[14]。近年来有学者采用荧光染色法进行靶段和正常肺组织的辨别,结果发现荧光染色法能有效标记交界面,达到理想的辨别效果[15]。为进一步提高肺段切除术的精准度,本研究对我院肺结节患者采用术前三维重建联合荧光染色法进行单孔胸腔镜肺段切除术,结果显示,观察组手术时间和段间交界面出现时间短于对照组,术中出血量少于对照组,这可能是由于通过三维重建图像,在术前即可辨别患者肺部血管及支气管等结构,明确解剖结构特点,提高了手术的精准度[16]。而通过吲哚菁绿进行荧光染色,能有效定位病灶范围,识别段间交界面的时间更短,节省了手术时间,减少了术中出血量[17]。在观察2组患者术后情况时发现,观察组术后拔管时间和住院时间均更短,总引流量更少,这是由于三维重建联合荧光染色法可进一步精准定位病灶和段间交界面,指导医师进行手术切除,对肺组织的损伤更小,引流量减少,拔管时间提前,患者恢复更快。通过观察2组患者的并发症发生情况发现,观察组并发症发生率更低,这是由于观察组可更精准地切除肺段,对肺组织的损伤更小,并发症发生率更低,手术安全性更高。肺段切除最重要的问题是如何获得足够的手术切缘[18]。术者通过术前三维重建能明确病灶的切除范围,获悉结节周边邻近的解剖标志,结合术中荧光染色所显示的段间交界面,较易获得满意的手术切缘。也有研究认为,采用三维重建联合荧光染色法进行肺段切除的患者容易出现无效染色,染色界线模糊不清[19]。出现这种情况的原因一般考虑以下几点:①虽然三维重建技术能使术者清晰观察到肺部解剖结构,但术前成像与术中的实际解剖仍然有一定差异,难以达到一一对应;②由于血管变异,不同肺段间存在细小

返支;③支气管动脉血供也可能会一定程度影响荧光染色。④局部肺气肿患者外周肺血管分布不足,易出现轮廓可视化问题[18]。

本课题组在研究过程中发现,高排数的 CT 和高质量的造影剂可使三维重建时动静脉和支气管显影更清楚,建议选用。研究显示,静脉注射吲哚菁绿剂量低于0.5 mg/kg时,出现过敏反应的概率仅为0.003%[15],且本研究暂无不良反应发生,说明应用低于0.5 mg/kg 的吲哚菁绿造影具有较高的安全性。荧光显影时间短暂,术中应用荧光显影剂标记段间交界面时需迅速、准确,特殊情况可重复荧光染色。荧光显影同时也存在一定的局限性:①难以在荧光染色远端的较深区域划分肺段;②在特殊患者(如肺气肿)中应用的有效性较低[20]。术前三维重建能提前规划及术中指导结节切除的范围,保障安全切缘,与荧光染色相辅相成。

综上所述,应用三维重建联合荧光染色法进行单孔胸腔镜肺段切除术能快速、清晰地显示肺段交界面,为手术提供技术支持,缩短手术时间,减少术中出血量,安全性相对较高,值得临床应用及推广。

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