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论著·临床

# 胸腔镜肺癌精准切除策略的肿瘤学疗效、肺功能、复发率及安全性研究

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**【摘要】目的** 比较胸腔镜肺癌精准切除策略与常规胸腔镜手术的肿瘤学疗效、肺功能、复发率及安全性。**方法** 选取 2019 年 5 月—2021 年 5 月苏州市立医院心胸外科收治肺癌患者 96 例,以随机数字表法分为常规组、精准组,各 48 例。常规组采用常规胸腔镜治疗,精准组给予胸腔镜肺癌精准切除治疗。比较 2 组手术一般情况、手术肺段切除分布、肿瘤学疗效、肺功能[一氧化碳弥散量( $D_LCO$ )、第一秒用力呼气容积( $FEV_1$ )、用力肺活量( $FVC$ )]、并发症、术后 1 年生存率和复发率。**结果** 与常规组比较,精准组手术时间、术后住院时间均缩短( $t/P=10.284/ <0.001, 4.240/ <0.001$ );术中出血量、术后引流量、术后置管时间,右上肺、右下肺、左上肺、左下肺肺段解剖切除,淋巴结清扫站数、淋巴结清扫枚数、手术切缘宽度比较,差异均无统计学意义( $P>0.05$ );与术前比较,2 组术后 1 个月  $D_LCO$ 、 $FEV_1$ 、 $FVC$  均降低,术后 3 个月均升高,但低于术前水平( $P<0.01$ ),而精准组术后 1 个月降低幅度低于常规组、3 个月升高幅度大于常规组( $t/P=2.950/0.004, 3.862/ <0.001, 3.848/ <0.001, 3.550/0.001, 2.837/0.006, 2.950/0.004$ );精准组并发症发生率为 4.17% (2/48),与常规组 6.25% (3/48) 比较,差异无统计学意义( $P>0.05$ );2 组术后 1 年 Kaplan-Meier 生存曲线、复发率比较,差异无统计学意义( $P>0.05$ )。**结论** 胸腔镜肺癌精准切除策略在段间平面识别、解剖靶肺段血管方面具有优势,能缩短手术时间,加快患者康复,最大程度保留肺功能,使肺段切除更为精准。

**【关键词】** 肺癌;胸腔镜肺癌精准切除策略;常规胸腔镜;肿瘤学疗效;肺功能;复发率;安全性**【中图分类号】** R734.2 **【文献标识码】** A

## Study on the oncological efficacy, pulmonary function, recurrence rate and safety of thoracoscopic lung cancer precise resection strategy

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**【Abstract】 Objective** To compare the oncological efficacy, lung function, recurrence rate and safety of precise thoracoscopic lung cancer resection strategy with conventional thoracoscopic surgery. **Methods** From May 2019 to May 2021, 96 patients with lung cancer were selected from the Cardiothoracic Surgery Department of Suzhou Municipal Hospital. They were randomly divided into conventional group and precision group with 48 patients each. The conventional group was treated with conventional thoracoscope, and the precision group was treated with precise resection of lung cancer by thoracoscope. The general condition of operation, surgical segmental resection distribution, oncological efficacy, pulmonary function [carbon monoxide diffusion capacity ( $D_LCO$ ), forced expiratory volume in one second ( $FEV_1$ ), forced vital capacity ( $FVC$ )], complications, 1-year survival rate and recurrence rate after operation were compared between the two groups. **Results** Compared with the conventional group, the operation time and postoperative hospital stay in the precision group were shortened ( $t/P=10.284/ <0.001, 4.240/ <0.001$ ). There was no significant difference in the amount of bleeding during the operation, the amount of drainage after the operation, the time of placing the tube after the operation, the anatomical resection of the right upper lung, the right lower lung, the left upper lung, and the left lower lung segments, the number of lymph node dissection stations, the number of lymph node dissection, and the width of the surgical margin ( $P>0.05$ ). Compared with that before operation,  $D_LCO$ ,  $FEV_1$ ,  $FVC$  in both groups decreased 1 month after operation, and increased 3

months after operation, but lower than that before operation ( $P < 0.01$ ). The decrease in precision group 1 month after operation was lower than that in conventional group, and the increase in precision group 3 months after operation was greater than that in conventional group ( $t/P = 2.950/0.004, 3.862/ < 0.001, 3.848/ < 0.001, 3.550/0.001, 2.837/0.006, 2.950/0.004$ ). The complication rate in the precision group was 4.17% (2/48), which had no significant difference compared with 6.25% (3/48) in the conventional group ( $P > 0.05$ ). There was no significant difference in Kaplan-Meier survival curve and recurrence rate between the two groups 1 year after operation ( $P > 0.05$ ). **Conclusion** Thoracoscopic lung cancer precise resection strategy has advantages in inter segment plane recognition and dissection of target pulmonary segment blood vessels, which can shorten the operation time, accelerate the patient's recovery, maximize the preservation of lung function, and make lung segment resection more accurate.

**【Key words】** Lung cancer; Thoracoscopic lung cancer precision resection strategy; Conventional thoracoscopy; Oncologic efficacy; Lung function; Recurrence rate; Safety

肺癌的病死率始终高居恶性肿瘤首位<sup>[1]</sup>。对于可切除的肺癌,既往的主要治疗模式是肺叶切除 + 纵隔淋巴结清扫<sup>[2]</sup>。随着肺部影像学技术的进步和肺癌筛查的推进,越来越多  $\leq 2$  cm 的肺癌得以早期检出,外科治疗策略转变为创伤更小的肺段切除术<sup>[3]</sup>。研究表明<sup>[4]</sup>,对部分早期肺癌,肺段切除可获取与肺叶切除类似的效果。手术路径规划、肺段交界的精准界定及靶病变与支气管、动静脉的解剖性分离是肺段切除的核心技术<sup>[5]</sup>。因肺段层面动静脉、支气管变异较大,按照传统解剖学经验的常规胸腔镜手术,易误伤动静脉与支气管,临床应用受限<sup>[6]</sup>。笔者术前通过影像学处理技术对手术路径进行预规划,明确全部靶病变位置及其周围解剖结构,术中辅助使用荧光染色法,可保证段间平面的精准定位。但由于该项技术新颖,国内外临床应用不久,相关报道较少。因此本研究纳入 96 例具有肺段切除术指征患者,通过肿瘤学疗效、肺功能、复发率及安全性方面的比较,阐明胸腔镜肺癌精准切除策略的应用价值,期待为临床实施肺段精准切除术提供参考,报道如下。

1 资料与方法

1.1 临床资料 选取 2019 年 5 月—2021 年 5 月苏州市立医院心胸外科收治肺癌患者 96 例,以随机数字表法分为常规组、精准组,各 48 例。2 组性别、年龄、吸烟史、组织学类型、病灶位置、肿瘤直径、临床分期、合并症、确诊至手术时间、肺癌家族史比较,差异无统计学意义( $P > 0.05$ ),见表 1。本研究经医院伦理委员会批准(2019 伦审第 136 号),患者及家属知情同意并签署知情同意书。

1.2 病例选择标准 (1) 纳入标准:符合肺癌诊断标准<sup>[7]</sup>;病灶直径  $\leq 2$  cm;CT 显示磨玻璃成分  $\geq 50\%$ 、原位腺癌或周围型腺癌;心肺功能无明显异常。(2) 排除标准:不能耐受手术者;对碘或特定造影剂过敏者;肺部病灶无法行肺段切除者;严重胸膜粘连者;肺周围

表 1 常规组与精准组肺癌患者临床资料比较

Tab. 1 Comparison of clinical data of lung cancer patients in conventional group and precision group

| 项目                            | 常规组<br>(n = 48)   | 精准组<br>(n = 48)   | $\chi^2/t$ 值 | P 值   |
|-------------------------------|-------------------|-------------------|--------------|-------|
| 性别[例(%)]                      |                   |                   | 2.050        | 0.152 |
| 男                             | 22(45.83)         | 29(60.42)         |              |       |
| 女                             | 26(54.17)         | 19(39.58)         |              |       |
| 年龄( $\bar{x} \pm s$ , 岁)      | 53.91 $\pm$ 10.76 | 56.84 $\pm$ 11.25 | 1.304        | 0.195 |
| 吸烟史[例(%)]                     | 18(37.50)         | 25(52.08)         | 2.064        | 0.151 |
| 组织学类型[例(%)]                   |                   |                   | 0.643        | 0.725 |
| 不典型腺瘤样增生                      | 7(14.58)          | 5(10.41)          |              |       |
| 原位癌                           | 27(56.25)         | 26(54.17)         |              |       |
| 微浸润腺癌                         | 14(29.17)         | 17(35.42)         |              |       |
| 病灶位置[例(%)]                    |                   |                   | 0.544        | 0.909 |
| 右上肺                           | 16(33.33)         | 19(39.58)         |              |       |
| 右下肺                           | 9(18.75)          | 7(14.58)          |              |       |
| 左上肺                           | 14(29.17)         | 13(27.08)         |              |       |
| 左下肺                           | 9(18.75)          | 9(18.76)          |              |       |
| 肿瘤直径( $\bar{x} \pm s$ , cm)   | 0.89 $\pm$ 0.29   | 0.94 $\pm$ 0.28   | 0.859        | 0.392 |
| 临床分期[例(%)]                    |                   |                   | 0.807        | 0.369 |
| I 期                           | 32(66.67)         | 36(75.00)         |              |       |
| II 期                          | 16(33.33)         | 12(25.00)         |              |       |
| 合并症[例(%)]                     |                   |                   |              |       |
| 糖尿病                           | 7(14.58)          | 3(6.25)           | 1.786        | 0.181 |
| 冠心病                           | 5(10.42)          | 2(4.17)           | 1.009        | 0.350 |
| 高血压                           | 1(2.08)           | 4(8.33)           | 1.244        | 0.217 |
| 确诊至手术时间( $\bar{x} \pm s$ , d) | 17.18 $\pm$ 4.50  | 16.59 $\pm$ 3.76  | 0.697        | 0.488 |
| 肺癌家族史[例(%)]                   | 1(2.08)           | 3(6.25)           | 0.261        | 0.610 |

型鳞癌或小细胞肺癌者;肺部多发结节且不在同一肺段内。

1.3 手术方法 精准组:患者行静吸复合全身麻醉,单肺通气,给予胸腔镜肺癌精准切除治疗。术前行胸部平扫、增强 CT 扫描、头颅磁共振成像、腹部和双侧肾上腺彩色超声、骨扫描检查,必要时行正电子发射计算机断层显像,明确病灶位置、性质,排除远处转移。将 CT 扫描数据导入图像后处理站,用 Mimics 软件重建三维模型,通过任意切割、动态旋转等细致、精准地

对三维重建后的血管分支进行定位、定量、定性分析,并掌握病灶范围、肺段支气管、血管情况。除特殊部位外,其他病灶均在 CT 引导下一次性使用肺结节定位针或硬化剂定位,为术中精准切除提供参考。依据术前规划情况,将靶肺段支气管与血管解剖出来,荧光胸腔镜调节为荧光模式,取 25 mg 吲哚菁绿 3 ml 与生理盐水 25 ml 混合液,经外周静脉快速注入,13 s 左右需切除的靶肺段不显色,其余肺组织变为绿色,标记并适形裁剪段间平面,切除靶肺段;采样活检 10~12 组淋巴结与第 5~6 组(病灶位于左侧上叶)、第 7~9 组(病灶位于下叶)、第 2~4 组(右上叶)肺门、纵隔淋巴结,行快速冰冻病理检查,若结果提示淋巴结阳性或浸润性癌改为肺叶切除。术毕胸腔置管引流。

常规组:采用常规胸腔镜治疗。麻醉、体位、肺通气、切口与精准组相同,根据镜下所见与传统的解剖学知识仔细辨别肺段门血管、支气管,将靶肺段血管、支气管离断后,以膨胀萎缩法判断段间平面,靶肺段切除期间,采样活检的方法同精准组,若结果提示淋巴结阳性或浸润性癌改为肺叶切除。术毕胸腔置管引流。

#### 1.4 观测指标与方法

1.4.1 手术一般情况:观察并记录术中出血量、手术时间、术后引流量、术后置管时间、术后住院时间等。

1.4.2 手术肺段切除分布:包括右上肺、右下肺、左上肺、左下肺肺段解剖切除情况。

1.4.3 肿瘤学疗效:包括淋巴结清扫站数、淋巴结清扫枚数、手术切缘宽度等。

1.4.4 肺功能检测:比较 2 组术前、术后 1 个月、术后 3 个月肺功能,包括一氧化碳弥散量(carbon monoxide diffusing capacity,  $D_LCO$ )、第一秒用力呼气容积(forced expiratory volume in one second,  $FEV_1$ )、用力肺活量(forced vital capacity,  $FVC$ ),使用肺功能仪(德国耶格公司 MasterScreen 型),患者采用坐位,使用鼻夹捏住鼻子,用嘴巴含住口器,指导患者进行呼气、吸气动作,自仪器上读取以上参数。

1.4.5 并发症发生情况:记录并发症发生情况,包括大咯血、持续漏气、肺扭转等。

1.4.6 随访预后:以门诊方式随访 1 年,计算 2 组术后 1 年生存率和复发率。

1.5 统计学方法 采用 SPSS 24.0 软件统计分析数据。计数资料以频数或率(%)表示,组间比较行  $\chi^2$  检验;正态分布的计量资料以  $\bar{x} \pm s$  表示,组间比较行  $t$  检验;采用 Kaplan-Meier 法分析 2 组术后 1 年生存率和复发率。 $P < 0.05$  为差异有统计学意义。

## 2 结果

2.1 2 组手术一般情况比较 2 组术中出血量、术后引流量、术后置管时间比较,差异无统计学意义( $P > 0.05$ );精准组手术时间、术后住院时间短于常规组( $P < 0.01$ ),见表 2。

2.2 2 组手术肺段切除分布比较 与常规组比较,精准组右上肺、右下肺、左上肺、左下肺肺段解剖切除分布比较差异无统计学意义( $P > 0.05$ ),见表 3。

表 3 常规组与精准组肺癌患者手术肺段切除分布比较 [例(%)]

Tab. 3 Comparison of surgical segmental resection distribution between conventional group and precision group of lung cancer patients

| 部位        | 精准组(n=48) | 常规组(n=48) | $\chi^2$ 值 | P 值   |
|-----------|-----------|-----------|------------|-------|
| 右上肺 S1    | 13(27.08) | 6(12.50)  |            |       |
| S2        | 5(10.42)  | 3(6.25)   |            |       |
| S3        | 1(2.08)   | 7(14.58)  |            |       |
| 右下肺 S6    | 1(2.08)   | 5(10.42)  |            |       |
| S7        | 0         | 2(4.17)   |            |       |
| S8        | 2(4.17)   | 2(4.17)   |            |       |
| S9        | 2(4.17)   | 0         | 0.544      | 0.909 |
| S10       | 2(4.17)   | 0         |            |       |
| 左上肺 S1+S2 | 8(16.67)  | 11(22.92) |            |       |
| S3        | 2(4.17)   | 1(2.08)   |            |       |
| S4+S5     | 3(6.25)   | 2(4.17)   |            |       |
| 左下肺 S6    | 6(12.50)  | 8(16.67)  |            |       |
| S7+S8     | 1(2.08)   | 1(2.08)   |            |       |
| S9        | 0         | 0         |            |       |
| S10       | 2(4.17)   | 0         |            |       |

2.3 2 组肿瘤学疗效比较 2 组淋巴结清扫站数、淋巴结清扫枚数、手术切缘宽度比较,差异无统计学意义( $P > 0.05$ ),见表 4。

表 2 常规组与精准组肺癌患者手术一般情况比较 ( $\bar{x} \pm s$ )

Tab. 2 Comparison of general conditions of lung cancer surgery between conventional group and precision group

| 组别  | 例数 | 术中出血量(ml)     | 手术时间(min)      | 术后引流量(ml)      | 术后置管时间(d)   | 术后住院时间(d)   |
|-----|----|---------------|----------------|----------------|-------------|-------------|
| 常规组 | 48 | 49.22 ± 11.35 | 186.02 ± 26.75 | 305.48 ± 67.82 | 4.09 ± 1.31 | 5.22 ± 1.18 |
| 精准组 | 48 | 46.91 ± 7.74  | 125.81 ± 30.49 | 289.63 ± 77.51 | 3.64 ± 1.22 | 4.19 ± 1.20 |
| t 值 |    | 1.165         | 10.284         | 1.066          | 1.742       | 4.240       |
| P 值 |    | 0.247         | <0.001         | 0.289          | 0.085       | <0.001      |

表 4 常规组与精准组肺癌患者肿瘤学疗效比较 ( $\bar{x} \pm s$ )

Tab. 4 Comparison of oncological efficacy between conventional group and precision group for lung cancer patients

| 组别         | 例数 | 淋巴结清扫站数 (站) | 淋巴结清扫枚数 (枚) | 手术切缘宽度 (cm) |
|------------|----|-------------|-------------|-------------|
| 常规组        | 48 | 2.10 ± 1.56 | 4.51 ± 1.27 | 2.48 ± 0.57 |
| 精准组        | 48 | 2.40 ± 1.47 | 4.89 ± 1.12 | 2.54 ± 0.61 |
| <i>t</i> 值 |    | 0.970       | 1.555       | 0.498       |
| <i>P</i> 值 |    | 0.335       | 0.123       | 0.620       |

2.4 2 组肺功能比较 与术前比较, 2 组术后 1 个月  $D_LCO$ 、 $FEV_1$ 、 $FVC$  均降低, 术后 3 个月均升高, 但低于术前水平 ( $P < 0.05$ ); 而精准组术后 1 个月降低幅度低于常规组, 3 个月升高幅度大于常规组 ( $P$  均  $< 0.01$ ), 见表 5。

表 5 常规组与精准组肺癌患者肺功能比较 ( $\bar{x} \pm s$ )

Tab. 5 Comparison of lung function between conventional group and precision group of lung cancer patients

| 组别                   | 时间     | $D_LCO$<br>( $ml \cdot mmHg^{-1} \cdot min^{-1}$ ) | $FEV_1$<br>(L) | $FVC$<br>(L)   |
|----------------------|--------|--|----------------|----------------|
| 常规组<br>( $n=48$ )    | 术前     | 19.96 ± 4.22                                       | 2.62 ± 0.59    | 3.59 ± 0.57    |
|                      | 术后 1 月 | 15.81 ± 2.99                                       | 2.05 ± 0.36    | 2.92 ± 0.42    |
|                      | 术后 3 月 | 17.75 ± 2.62                                       | 2.24 ± 0.43    | 3.20 ± 0.49    |
| 精准组<br>( $n=48$ )    | 术前     | 20.07 ± 3.14                                       | 2.55 ± 0.53    | 3.68 ± 0.61    |
|                      | 术后 1 月 | 17.56 ± 2.82                                       | 2.38 ± 0.47    | 3.30 ± 0.54    |
|                      | 术后 3 月 | 19.81 ± 3.05                                       | 2.51 ± 0.50    | 3.52 ± 0.57    |
| <i>F/P</i> 常规组内值     |        | 12.067/ <0.001                                     | 10.338/ <0.001 | 16.441/ <0.001 |
| <i>F/P</i> 精准组内值     |        | 9.725/ <0.001                                      | 11.688/ <0.001 | 10.002/ <0.001 |
| <i>t/P</i> 术后 1 月组间值 |        | 2.950/ 0.004                                       | 3.862/ <0.001  | 3.848/ <0.001  |
| <i>t/P</i> 术后 3 月组间值 |        | 3.550/ <0.001                                      | 2.837/ <0.001  | 2.950/ <0.001  |

2.5 2 组并发症比较 2 组均无中转开胸患者, 均未发生大咯血、持续漏气、肺扭转等严重并发症。精准组术后出现肺不张 1 例(考虑与患者年龄偏大有关, 给予吸痰处理后肺部复张)、心房颤动 1 例(给予胺碘酮后心律转为窦性), 常规组术后出现肺不张 2 例(重新置管、吸痰、雾化后肺部复张)、肺部感染 1 例(给予抗菌药物治疗后缓解)。精准组并发症发生率为 4.17% (2/48), 常规组为 6.25% (3/48), 2 组并发症发生率比较, 差异无统计学意义 ( $P = 1.000$ )。

2.6 2 组术后 1 年生存率、复发率比较 随访 1 年, 精准组失访 1 例, 常规组无失访病例。精准组生存 47 例, 常规组生存 45 例, 2 组 Kaplan-Meier 生存曲线比较, 差异无统计学意义 ( $\chi^2 = 0.134, P = 0.248$ ); 术后 1 年, 精准组复发率为 4.17% (2/47), 常规组为 8.33% (4/48), 2 组复发率比较差异无统计学意义 ( $\chi^2 = 0.156, P = 0.693$ )。

### 3 讨论

彻底切除靶病灶、最大程度保留健康肺组织是肺段切除术的目标, 因此如何以病灶为中心, 并结合患者肺部解剖特征制定个性化精准的手术方案成为胸外科医师研究的热点之一<sup>[8]</sup>。

常规胸腔镜肺段切除术因肺段层面解剖变异, 可能出现血管和支气管的误断、少断, 引起术中肺段平面的错判, 影响病灶切除范围, 难以实现精准切除<sup>[9]</sup>。因此有报道尝试对段间交界识别的方法进行改进, 以荧光法确立段间交界线, 发现与常规胸腔镜手术相比, 其段间平面出现的更快, 手术时间更短<sup>[10]</sup>。本研究在此基础上, 在术前运用 CT 扫描和三维重建技术进行虚拟手术规划, 细致、精准地对三维重建后的血管分支、病灶范围、肺段支气管进行分析, 准确定位靶肺段, 结果显示在该指导方法下的胸腔镜肺癌精准切除策略的肿瘤学疗效与常规胸腔镜手术相似, 但在缩短手术时间、加快患者术后康复方面具有优势。分析其原因, 精准组术前通过影像学处理技术, 准确定位了病灶的位置、范围、动静脉及支气管情况, 缩短了术中手术医师对以上解剖结构的辨别判断时间, 且术中使用荧光法, 注射吲哚菁绿后 13 s 左右段面即出现, 而常规组一般需 15 min 左右才能识别段面, 同时常规组需将肺靶段充气膨胀, 而精准组则无需进行这一操作, 所以能更快更精准地完成手术<sup>[11-12]</sup>。

肺段切除术的一个重要目的是尽可能多地保留术后肺功能, 原因在于术后肺功能情况决定了患者术后生存质量<sup>[13-14]</sup>。本研究结果显示, 2 组术后 1 个月相关肺功能指标均低于术前, 术后 3 个月均高于术后 1 个月, 这与术后恢复的实际情况相符合。术后 1 个月, 患者因受手术切除的影响, 肺功能降低, 而至术后 3 个月, 手术切除病灶对肺功能的影响逐渐缩小, 故肺功能逐渐恢复。胸腔镜肺癌精准切除策略术后肺功能保留更好, 笔者认为其原因是, 胸腔镜肺癌精准切除策略术前三维重建与虚拟手术规划, 能避免误断或损伤支气管, 使所剩余肺段的肺功能最大程度保留, 且术中以荧光法判断段间平面, 使肺段间交通支的干扰最小化, 故在改善肺功能方面具有优势<sup>[15-17]</sup>。常规胸腔镜手术因术中使用膨胀萎缩法, 导致段间平面存在较大误差, 从而影响术后肺功能<sup>[18-20]</sup>。

从理论上讲, 常规胸腔镜手术对解剖结构的辨认依赖的是手术医师掌握的肺部解剖学知识, 但因个体变异、视野等因素, 可能造成肺段血管、支气管、段门平面切除不精准, 使术后局部肺段肺不张, 甚至引起咯血等并发症<sup>[21-24]</sup>。但本研究结果显示, 2 组并发症相似,

可能与手术医师临床经验丰富、肺部解剖学知识掌握扎实等有关。值得注意的是,精准组术中吲哚菁绿的应用剂量目前尚未形成统一的意见,国外有研究建议 3~5 mg/kg<sup>[25]</sup>,本研究参考国内大多核心文献介绍,不论患者性别、年龄、体质量等,均给予 25 mg,与国外部分学者建议的差异较大,一方面与人种不同,机体对代谢吲哚菁绿率不同有关,另一方面可能是部分学者担忧定位效果,使吲哚菁绿应用剂量增加,而本研究吲哚菁绿的应用剂量下发现定位效果与安全性良好,未出现吲哚菁绿相关的不良反应,具有临床可行性,但给予其他剂量是否会影响手术效果仍不能明确,有待后续统一手术方法,比较不同剂量吲哚菁绿的效果,以进一步阐明吲哚菁绿的应用剂量。

综上,胸腔镜肺癌精准切除策略在段间平面识别、解剖靶肺段血管方面具有优势,能缩短手术时间,加快患者康复,最大程度保留肺功能,使肺段切除更为精准。

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