Surgical technique of lung segmental resection with two intersegmental planes†

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Received 10 September 2012; received in revised form 26 November 2012; accepted 10 December 2012

Abstract

Lung segmental resection is of two types: a simple type with resection of only one intersegmental plane, such as lingual or superior segmentectomy; and a complicated type with resection of two or more intersegmental planes, such as anterior segmentectomy. We present a method of identifying the intersegmental plane by physiological function. First, we cut the segmental pulmonary artery and vein. The entire lobe is then inflated with pure oxygen for 5 min. Immediately after oxygen inflation, the segmental bronchus is deflated and stapled. After a couple of minutes, the intersegmental plane is easily detected. In 117 patients who underwent segmentectomy, mean blood loss was 122 ± 193 ml and mean duration of drainage was 3.5 ± 4.8 days. Postoperative complications related to operative procedures occurred in 14 cases (12.0%). Our method of detecting intersegmental planes is convenient and useful for subsegmental resection, particularly for complicated-type cases.

Keywords: Lung segments • Segmentectomy • Intersegmental plane

SURGICAL TECHNIQUE

In our surgical procedure, we cut the segmental pulmonary artery and the vein. The entire lobe is then inflated with pure oxygen for 5 min. Immediately after oxygen inflation, the segmental bronchus is deflated and stapled. After a couple of minutes, the intersegmental plane is easily detected.

The logic of this method can be explained as follows. Lung tissue that has a segment of the pulmonary artery and the vein contributes to gas exchange. The alveoli contain a high concentration of oxygen during oxygen inflation. The alveoli in which the pulmonary circulation continues can perform gas exchange and absorb oxygen. Conversely, alveoli without pulmonary circulation cannot be involved in gas exchange and retain oxygen inside. The border between alveoli with or without oxygen inside defines the intersegmental plane (Fig. 1A). We perform segmental resection along the intersegmental vein at the central portion of the hilum and peripheral lung parenchyma. A stapler and electro-cautery or ultrasonic scissors are used along this plane for the segmental resection.

CLINICAL EXPERIENCE

Of 117 patients who underwent segmentectomy (64 men, 53 women; mean age, 64.9 ± 12.1 years), VATS (Supplementary Video 1 Assisted thoracoscopic surgery) segmentectomy was performed in 72 patients (66.7%). Segmentectomy was performed to remove a primary lung cancer in 65 patients. Table 1 shows the 120 resected segments, which included bilateral simultaneous segmentectomy in 3 cases. These 120 resections included 85 cases with simple-type procedures involving resection of only 1 intersegmental plane and 35 cases with complicated-type procedures involving resection of 2 or more intersegmental planes. Mean blood loss was 122 ± 193 ml. The intersegmental plane was identified using our method in all cases. Mean duration of drainage was 3.5 ± 4.8 days. Postoperative complications related to the operative procedures occurred in 14 cases (12.0%), including pneumonia in 5 cases, prolonged air leak in 4, atelectasis in 4 and late pneumothorax in 1. One case with prolonged air leakage required reoperation.

DISCUSSION

Recently, segmental resection has frequently been performed for early lung cancer or metastatic lung tumour. Achieving anatomical segmental resection requires a deep knowledge of the bronchovascular structure. In addition, identification of the intersegmental plane in peripheral lung parenchyma is important for segmental resection. It is important issue which remained or resected segments are inflated for the identification of the intersegmental plane. Differential inflation of segments to be retained has been performed to help demarcate the diseased segment [1]. Tsubota et al. [2] first developed a unique method in which the segments to be resected were expanded. He expanded the entire lobe after closing the bronchus of the resected...
segment. Okada et al. [3] demonstrated identification of the intersegmental plane by differential inflation in which the segment to be resected is selectively inflated by jet ventilation, showing that an appropriate surgical view is possible with a minimally invasive approach. Our method differs slightly from that described by Tsubota et al. and Okada et al. We believe that the parenchymal segment to be resected should not contribute to gas exchange. We therefore focussed on pulmonary circulation using pure oxygen. We identified the intersegmental plane, detected in the segment in which the pulmonary artery alone was closed, without closing the bronchus and the vein (Fig. 2). We confirmed our method was based on the pulmonary circulation. This method also contributes to more complicated segmental resections, such as subsegmental resection (e.g. right posterior and anterior sub-segments; Fig. 2B). In the COPD case, indeed, we think it is a little hard to detect the intersegmental plane compared with normal parenchyma. However, there is a normal lung tissue area in the COPD case. We could see the plane at the normal area in emphysematous parenchyma.

Table 1: 120 resected segments including bilateral simultaneous segmentectomy in 3 cases

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<thead>
<tr>
<th>Right (n: 45)</th>
<th>Left (n: 75)</th>
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<tbody>
<tr>
<td>S1</td>
<td>S1 + 2</td>
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<tr>
<td>S2</td>
<td>S3</td>
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<tr>
<td>S3</td>
<td>S6'</td>
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<td>S10</td>
</tr>
<tr>
<td>S8</td>
<td>S2b + S3a</td>
</tr>
<tr>
<td>S9</td>
<td>S9 + 10</td>
</tr>
<tr>
<td>S10</td>
<td>S7 + 8 + 9 + 10'</td>
</tr>
</tbody>
</table>

S1: apical; S2: posterior; S3: anterior; S4: superior; S5: inferior; S6: superior; S7: medial basal; S8: anterior basal; S9: lateral basal; S10: posterior basal; a: posterior subsegment; b: anterior subsegment. Cases without an asterisk (*) represent the complicated type. Simple type.

Figure 1: Simple type with resection of only one intersegmental plane and complicated type with resection of more than one intersegmental plane.
segmental bronchus seems difficult to perform. Sekine et al. [4] also demonstrated that transbronchial indocyanine green injection into the relevant bronchus with the use of an infrared thoracoscope allows identification of intersegmental lines and planes during thoracoscopic segmentectomy. However, that method represents the same basic strategy as the jet ventilation method of Okada et al. Misaki et al. [5] demonstrated detection of intersegmental lines without inflating the lung using infrared thoracoscopy with intravenous injection of indocyanine green. That method represents the same strategy as our method from the perspective of pulmonary circulation. However, in their method, the intersegmental lines can be observed only for 3.5 min because the dye is washed out in the presence of pulmonary circulation. In addition, the risk of allergy to the dye must be considered.

In conclusion, our method of detecting intersegmental planes is convenient and useful for subsegmental resection, particularly for complicated-type cases.

SUPPLEMENTARY MATERIAL

Supplementary material is available at ICVTS online.

Conflict of interest: none declared.

REFERENCES


Figure 2: (A) We identified the intersegmental plane, detected in the segment in which the pulmonary artery alone was closed, without closing the bronchus and the vein in left S1 + 2 (apical, posterior) and S3 (anterior) segmentectomy. (B) Intersegmental plane in subsegmental resection: S2b (anterior subsegment of posterior segment) and S3a (posterior subsegment of anterior segment).