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## Dual outline of navigating utensil in thoracoscopic segmentectomy: a new method

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### Abstract

Thoracoscopic segmentectomy requires an adequate surgical margin; however, only a few reports have described the procedure of how to maintain a constant distance from the tumour. We here suggest a novel simple method to secure an adequate surgical margin: the dual outline of navigating utensil in thoracoscopic segmentectomy (DONUTS) method. We used a DONUTS indicator sheet produced from a 1.5-mm thick absorbed sheet with a proper diameter to secure an adequate surgical margin. The indicator sheet, which was affixed to the pleura, indicated a new resection line. With this new line, an additional excision was performed in addition to conventional segmentectomy. The clinical records of 9 patients who underwent treatment with the DONUTS method between August 2011 and December 2013 were retrospectively reviewed. No postoperative complications of loco-regional recurrence were observed over a mean period of 20.3 months.

**Keywords:** Thoracoscopy • Segmentectomy • Computer applications • Surgical instrument

### INTRODUCTION

Thoracoscopic segmentectomy is an accepted method for small-sized non-small-cell lung cancer (NSCLC) and metastatic lung tumours [1–3], because anatomical pulmonary segmentectomy has the theoretical advantages of preserving the pulmonary function and of increasing the potential for a second resection with a subsequent pulmonary tumour [4]. It is crucial to ensure that there are no residual cancer cells, which can lead to a surgical margin relapse [5]. If the tumour is located near an anatomical intersegmental plane, then it is inconclusive as to whether an additional partial resection extended to the neighbouring segment or additional subsegmentectomy/segmentectomy is required. We here suggest a novel simple method, the dual outline of navigating utensil in thoracoscopic segmentectomy (DONUTS) method, which secures an adequate surgical margin.

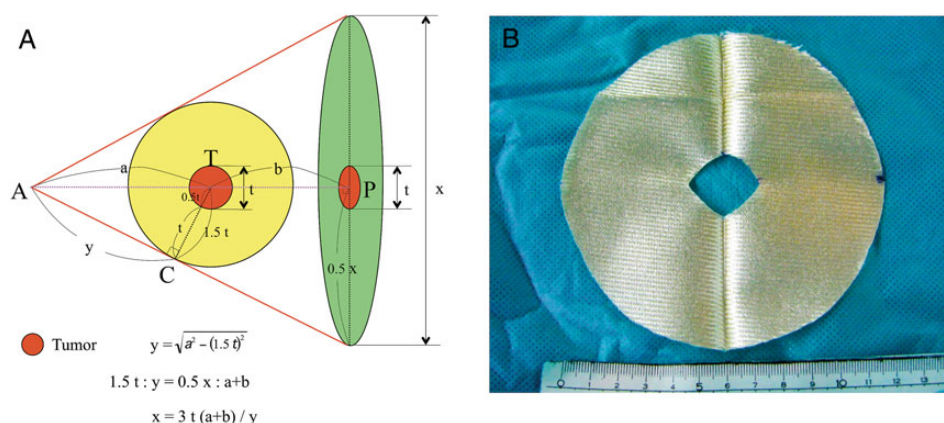
### METHODS

Preoperative marking without piercing the pulmonary parenchyma is performed on the day of surgery [6]. The patient is placed in the lateral position on the gantry, and under CT guidance, the centre of the tumour (Point T in Fig. 1A) and the segmental artery (Point A) are located. An A–T line, via Point A and Point T, is

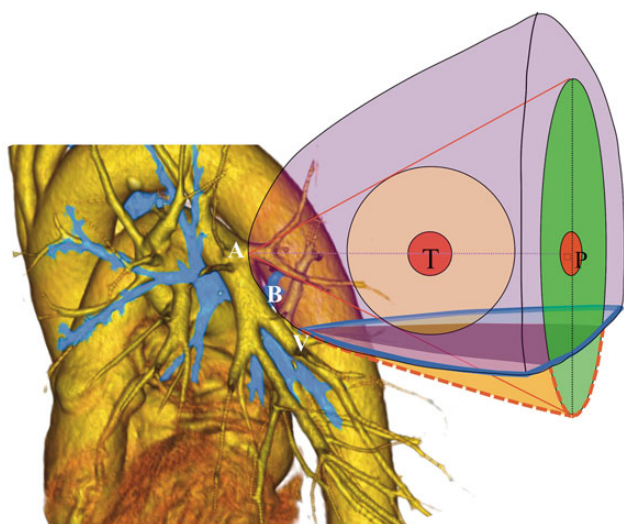
extended towards the visceral pleura, and the point is located where the line meets the pleura (Point P). The maximum diameter ( $t$ ) of the tumour, the A–T distance ( $a$ ), and the T–P distance ( $b$ ) are measured. To secure an adequate surgical margin, a globe with its radius,  $1.5t$  (1.5 times longer than the maximum tumor diameter), is assumed. A line is drawn to make contact with this globe from Point A, and the point (Point C) is located where the line contacts the globe. The A–C distance ( $y$ ) is given by  $y = \sqrt{a^2 - (1.5t)^2}$  (Fig. 1A). A 16-gauge indwelling catheter is inserted through the skin to the parietal pleura just above Point P. The needle is removed, and the catheter is fixed to the thoracic wall.

As already described in a previous report [6], the patient is placed in a lateral position, and the thoracic cavity is entered through a trocar port. A guidewire is inserted through the catheter, the catheter is removed and a central venous catheter is threaded over the guidewire. The tip of the catheter is pulled out through the trocar port onto the extracorporeal side and is equipped with a round stype. The tip of the catheter is then pulled back into the thoracic cavity, and the stype is fixed to the chest wall. After inflation of the lung, pyoktanin blue is injected through the catheter, thereby staining the stype. The pigmentation of the visceral pleura (Point P) is visually confirmed by deflation of the lung. Soft coagulation is performed with the pigmentation of the visceral pleura.

Thoracoscopic segmentectomy (four ports measuring 17 mm in diameter) is started. The suitable segmental arteries are ligated,



**Figure 1:** (A) Method for the diameter ( $x$ ) of a DONUTS indicator sheet. A, the segmental artery; C, the point where the line (drawn from A) makes contact with the globe;  $y$ , the distance between Point A and Point C; T, the centre of the tumour; P, the visceral pleura which the A-T line is extended towards;  $t$ , the maximum diameter of the tumour;  $a$ , the distance between Point A and Point T;  $b$ , the distance between Point T and Point P. (B) The DONUTS indicator sheet. See text for more details. DONUTS: dual outline of navigating utensil in thoracoscopic segmentectomy.



**Figure 2:** An additional excision (orange area) added to conventional segmentectomy (purple area) by the DONUTS method. The DONUTS indicator sheet (green area) is affixed to the pleura, so that the centre of the indicator coincides with Point P. If this indicator sheet protrudes from the inflation-deflation line (blue line), a new resection line (orange dot line) is generated. A, the segmental artery; T, the centre of the tumour; P, the visceral pleura which the A-T line is extended towards; B, the segmental bronchus; V, the intersegmental vein. DONUTS: dual outline of navigating utensil in thoracoscopic segmentectomy.

and are either divided or dissected with a stapler; then the intersegmental pulmonary veins are ligated and divided to interrupt the draining lymphatics, including the intersegmental planes. The bronchus is detached at the hilum. After inflation of the lung on the operating side, the bronchus is dissected with a stapler. Under subsequent deflation of the lung, the inflation-deflation line is depicted as the anatomical intersegmental line.

A DONUTS indicator sheet is produced from a 1.5-mm thick sheet (Surgicel Nu-Knit; Ethicon, Inc., Somerville, NJ, USA), with a diameter ( $x$ ) calculated by the following:  $x = 3t(a + b)/y$ . A DONUTS hole is made in the centre of the sheet with a diameter of  $t$  (Fig. 1B). The sheet is affixed to the pleura so that its centre coincides with the pigmented site of the visceral pleura. A circle

protruding from the inflation-deflation line is drawn on the visceral pleura along the outline of the sheet with soft coagulation. The drawn circle and the line drawn between the edges of the sheet and the intersegmental pulmonary veins are the new resection line (Fig. 2); the visceral pleura is thereafter dissected using electrocautery, and the pulmonary parenchyma is dissected along this new line with stapling devices (Video 1).

## RESULTS

Between August 2011 and December 2013, we performed the DONUTS method in 9 patients (4 men and 5 women with a mean age of 70 years: 3 adenocarcinoma, 1 squamous cell carcinoma, 4 metastatic lung cancer and 1 granulation). The mean diameter ( $t$ ) of the tumour was 14.3 (range 7–20) mm, the A-T distance ( $a$ ) 46.4 (range 27–66) mm and the T-P distance ( $b$ ) 19.9 (range 12–31) mm. No loco-regional recurrence was observed during the mean observation period of 20.3 months.

## DISCUSSION

Our simple DONUTS method indicates that the surgical margin to the tumour is judged to be long enough if the margin distance is greater than the maximum tumour diameter; if not, the conic part including the globe, which has a radius 1.5 times longer than the maximum tumour diameter, is added.

When a wedge resection is performed, there is no clear information regarding what constitutes an adequate margin distance. A multivariate analysis has shown that both the margin distance and maximum tumour distance are independent variables, and that a malignant positive margin is not found when the margin distance is greater than the maximum tumour diameter [7]. A previous report proposed a method of segmental resection, pulmonary artery-guided segmentectomy, because conventional segmentectomy, which divides the lung along the intersegmental planes, invariably could not interrupt the draining lymphatics including the intersegmental planes commonly considered to be a source of residual cancer cells [8].



**Video 1:** The dual outline of navigating utensil in thoracoscopic segmentectomy (DONUTS) method to secure an adequate surgical margin. After marking of the visceral pleura (Point P), thoracoscopic segmentectomy is started through the four ports. The A6 is divided with a stapler, V6 is ligated and divided, and the B6 is dissected with a stapler. A DONUTS indicator sheet is produced from a 1.5-mm thick sheet, and affixed to the pleura so that the centre of the indicator coincides with the marking site. Along the new resection line set on the indicator sheet, the visceral pleura is dissected using electrocautery and the pulmonary parenchyma is dissected with a stapler.

We believe that our new method, which is a pulmonary artery-guided segmentectomy and is able to keep a distance from the surgical margin to the tumour greater than the maximum tumour

diameter, can solve the problems typically associated with the conventional methods of segmentectomy.

**Conflict of interest:** none declared.

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