Three-Dimensional Pulmonary Model Using Rapid-Prototyping in Patient with Lung Cancer Requiring Segmentectomy

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Thoracoscopic pulmonary segmentectomy of the lung is sometime adopted for the lung cancer, but a problem with segmentectomy is variable anatomy. Recently, we are exploring the impact of three-dimensional models using rapid-prototyping technique. It is useful for decision making, surgical planning, and intraoperative orientation for surgical treatment in patient with lung cancer who underwent pulmonary segmentectomy. These newly created models allow us to clearly identify the surgical margin and the intersegmental plane, vessels, and bronchi related to the cancer in the posterior segment. To the best of our knowledge, there are few reports describing a pulmonary model so far.

Keywords: rapid-prototyping technique, pulmonary segmentectomy, lung cancer, thoracoscopic surgery

Introduction

Thoracoscopic (VATS) segmentectomy of the lung is sometime adopted for the lung cancer, but a problem with segmentectomy is variable anatomy. There are some reports reporting the effectiveness of the computed tomographic angiography in segmentectomy.1 And we have preliminarily reported three-dimensional (3-D) virtual lung imaging to deal with this problem.2,3 Recently, we are exploring the impact of 3-D pulmonary models using rapid-prototyping technique for decision making, surgical planning, and intraoperative orientation for surgical treatment in patient with lung cancer who underwent pulmonary segmentectomy. To the best of our knowledge, there are few reports describing a pulmonary model so far.4

Case Report

Technique

Based on volume analyzer Synapse Vincent data (Fujifilm Medical Co., Ltd., Tokyo, Japan) derived from contrast medium-enhanced computed tomography scans, we were able to fabricate 3-D mixed-color replicas of the pulmonary anatomy using a 3-D model printer (Connex, Stratasys Ltd., Japan). We obtained institutional ethics committee approval before this research. The models were durable and they were taken to the operating room.

Case

We recently used this technique for treating a 73-year-old male patient who had developed a growing consolidation in the posterior segment (S3) of the left upper lobe after undergoing a right upper lobectomy. A shadow identified on scans suggested adenocarcinoma, and thoracoscopy for a left posterior segmentectomy of the lung was consequently scheduled. In 3-D model, the bronchi, pulmonary arteries, and veins appear in different colors due to their differences in density (Fig. 1).

On the basis of the exact anatomic understanding obtained our 3-D model using rapid-prototyping technique,
we determined the best approach for performing a margin-free resection (Fig. 2). Following successful completion of the thoracoscopic S3 segmentectomy, the patient’s postoperative course was uneventful, and he was subsequently discharged on postoperative day seven.

**Discussion**

It was recommended that when expertise exists, the surgeon should use a minimally invasive or thoracoscopic approach to realize perioperative and functional benefits in patients. The benefits of simulating a lung segmentectomy using multi-detector computed tomography angiography have been stressed to determine the preoperative anatomical intersegmental plane by visualizing the pulmonary vein branches. Furthermore, we have been advocating the tailor-made virtual lung, which showing the detailed anatomy of the bronchi, pulmonary vessels, and intersegmental plane by using the computed tomography angiography and bronchography.

Rapid-prototyping has proved to be a useful tool in maxillofacial surgery, reconstructive surgery, neurosurgery, orthopedics, and adult and pediatric cardiac surgery. These models can be useful for preoperative decision making and surgical procedure planning. However, there are few reports regarding a pulmonary model using rapid-prototyping; therefore, we began to construct models for complex pulmonary resection for thoracoscopic segmentectomy.

It is difficult to measure the distance between the tumor and the lung structures using computed tomography, because it is 3-D. But in 3-D model in this manuscript, you can sense or measure the accurate distance of the depth. This newly created model allows us to clearly identify the surgical margin and the intersegmental plane, vessels, and bronchi related to the cancer in S3. The 3-D representations also appear more realistic than computed tomography images. We believe that construction of such models is useful for thoracoscopic segmentectomy procedures and other complicated surgeries of the chest.

**Disclosure Statement**

None declared.

**References**

3) Akiba T, Morikawa T, Ohki T. Thoracoscopic lung segmentectomy simulated by a tailor-made virtual...