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Effect of resection line geometries on the stress distribution near the resection line

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Abstract

Introduction. Primary spontaneous pneumothorax is a disease caused by the breakdown of lung cysts on the lung surface. The treatment is surgical resection of the lung, including the failed lung cyst. However, pneumothorax may recur after surgery due to new lung cysts that develop near the resection line. In contrast, it is believed that a change in the resection method of the affected area can prevent recurrence of pneumothorax. It may be due to the stresses applied by the different shapes of the resection. In this study, a finite elements analysis was performed on a simple model of a lung after resection surgery to confirm the difference in the stress generated near the resection line due to the difference in the shape of the resection line. **Analytical Model.** Figure 1 shows a simplified model of the lungs, assuming a simple dome shape. Model A is a normal lung, and models B and C are postoperative lungs; model B has a I-shaped resection line used in pneumothorax resection, and model C has a V-shaped resection line used in lung tumor resection. Each model comprises a plate with 0.1 mm thickness on the surface and solid elements inside the model. **Analysis Conditions.** Table 1 shows the analytical conditions used in this analysis. The stress-strain diagram of the pulmonary pleura was obtained from the pleura of a porcine lung. The lung expansion was reproduced by thermal-expanding solid elements virtually. **Results And Discussion.** The analysis results under the above conditions showed that Model A, which assumes healthy lungs, was loaded evenly across the entire model and that the load was applied to the entire model. In contrast, Model B showed high loading near the resection line. Model C, which has a V-shaped resection line, did not show the high loading near the resection line that was observed in Model B. It is due to the difference in the shape of the resection line. Because the I-shaped line cannot follow the deformation of the lung when the lung is inflated by inspiration, and a high load is applied near the resection line, while the V-shaped resection line itself is less deformed.

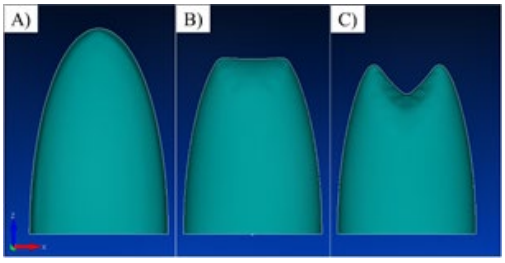

Figure 1. Analysis models A) Normal model, B) I-shaped resection model, C) V-shaped resection model

Table 1. Analysis conditions

Model	Simplified model
Solver	FEMAP with NX Nastran SOL 601 non-linear static analysis
Young's modulus	Non-linear stress-strain curve
Load	Thermal expansion
Pleural thickness	0.1mm