# Controlling Air Leaks Using Free Pericardial Fat Pads as Surgical Sealant in Pulmonary Resection

Takeshi Ikeda, MD, PhD, Masato Sasaki, MD, PhD, Narihisa Yamada, MD, Atsushi Takamori, MD, Sawaka Tanabe, MD, Akitoshi Okada, MD, Kayo Sakon, MD, Tae Mizunaga, MD, and Takaaki Koshiji, MD

Division of Thoracic Surgery, Department of Surgery, Faculty of Medical Sciences, University of Fukui, Fukui, Japan

*Background.* **This study evaluated the feasibility and efficacy of a new operative method for controlling intraoperative air leaks using free pericardial fat pads as a covering sealant in pulmonary resection.**

*Methods.* **To manage air leaks that must be controlled in pulmonary resection at the first water sealing test, collected free pericardial fat was used as a covering sealant and sewn on by the suture closing the lesion. In cases of uncontrolled air leaks at the second sealing test, fibrin glue was used to fill the residual lesion between the fat and visceral pleura. Fifty-one eligible patients were enrolled in this study to evaluate the duration of postoperative air leaks and the condition of the implanted fat on chest computed tomography (CT) 6 months later.**

*Results.* **The mean duration of postoperative air leaks was 1.05 ± 1.84 days in the 39 cases that received the pericardial fat covering technique only and 2.66 ± 3.42 days in the 12 cases that received the pericardial fat covering technique combined with fibrin glue. Prolonged alveolar air leaks occurred in 1 case and 2 cases, respectively. No cases required conversion to conventional methods, and there were no further adverse events. On follow-up chest CT approximately 62.7% of obvious engrafted fat survived.**

*Conclusions.* **Using free pericardial fat pads as a sealant to control air leaks in pulmonary resection is safe and has good feasibility and potent efficacy. This new method can be an innovative technique for preventing prolonged air leaks.**

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The development of air leaks from lung parenchyma is one of the most common complications after pulmonary resection, and prevention of prolonged alveolar air leaks (PAALs: more than 7 days) is a significant issue in thoracic surgery to reduce the risk of postoperative complications. Not only the conventional methods, but also new techniques using various sealants have been adopted. However, there is no ideal technique for control of intraoperative pulmonary air leaks. To control intraoperative air leaks and reduce the incidence of PAALs there are some problems that must be overcome. These problems occur in cases with underlying pulmonary diseases with a structural disorder that causes fragility of lung parenchyma that makes it difficult to suture the lesion and results in a long time until the air leaks disappear. Similarly, systemic underlying disease causes systemic tissue fragility, and protracted wound healing is also a serious problem. In addition, air leaks from a delamination area of the hilum or a laceration involving stumps of autosutures cause difficulty in suturing or sealing because of the complex shape of the lesion causing the air leaks. To overcome the structural and technical problems while looking for an entirely new approach, we noted a previous report concerning the possibility of using free pericardial fat pads (FPFPs) as sealants for preventing air leaks [1]. The aim of this study was to assess the feasibility and efficacy of a new technology using FPFPs for intraoperative pulmonary air leaks.

## Patients and Methods

This study was performed with the approval of the Ethics Committee of the University of Fukui Faculty of Medical Sciences, and written informed consent was obtained from each patient enrolled in this study before the operation. The study was conducted from April 2011 to March 2013. To maintain uniformity of the procedure, only 1 expert operator (T. I.) from our institution was selected for this study. During that period the operator undertook 179 cases of pulmonary resection, of which 51 patients were eligible and enrolled in this study.

On the assumption that operative methods must be adaptable to any operative case, there were no exclusion criteria and all pulmonary resections in our institution were potential subjects for this study during that period. However, operations for spontaneous pneumothorax and pneumonectomy were not included because there have been no cases of PAALs during these cases in the past decade in our institution. Pulmonary resections were

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Address correspondence to Dr Ikeda, Division of Thoracic Surgery, Department of Surgery, University of Fukui Faculty of Medical Sciences, 23-3 Matsuoka- Shimoaizuki, Eiheiji, Fukui 910-1193, Japan; e-mail: tikeda@u-fukui.ac.jp.


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performed under general anesthesia with one-lung ventilation through a 6- to 8-cm lateral muscle-sparing thoracotomy by video-assisted thoracoscopic surgery. The FPFP harvesting was performed under complete thoracoscopic vision. On the other hand, suturing the lesion with the FPFP was performed by direct vision through the thoracotomy. The following conditions were set prospectively to ensure patient safety and maximize potential benefit, and the rules were followed strictly. Water sealing tests were to be performed at the end of the surgical procedure by inflating the residual lung with a pressure of 25 cm $H_2O$. If air leaks were detected, the grade was to be classified subjectively into 3 groups as mild (countable bubbles), moderate (a stream of bubbles), or severe (coalescent bubbles), based on the previous report of D'Andrilli and colleagues [2]. The cases in the moderate to severe group were to undergo manipulation of pericardial fat to provide cover as a surgical sealant for air leaks, and the mild group was to be just observed because almost all mild cases are expected to resolve spontaneously, and this in fact occurred. The mean durations of air leaks and chest tube drainage were 2.36 $\pm$ 1.26 days and 3.35 $\pm$ 1.30 days, respectively. After the first manipulation to close and seal the air leaks was performed, a second water sealing test was to be performed to evaluate the effectiveness of the procedure. Patients showing mild or less leakage were regarded as curable cases requiring no further intervention and the operation was to be completed. If the air leaks remained moderate or greater after fat covering at the second sealing test, fibrin glue was to be sprayed between the fat and visceral pleura to fill the interspace. In cases in which air leaks still remained moderate or greater at the third water sealing test, the FPFP was to be abandoned and the procedure was to be converted to our conventional method using absorbable mesh and fibrin glue to ensure the patient's safety. The strategy was to ensure that air leaks were controlled to the mild level or less by the end of the operation.

After confirming disappearance of air leaks and that the fluid output was no more than 200 mL/day, a 24-hour chest tube clamping test was undertaken to confirm no apparent abnormalities on chest x-ray and the chest tube was then removed. The duration of chest tube drainage days was defined as from the day after operation to the day of chest tube removal.

Follow-up chest computed tomography (CT) was performed 6 months later and the existence of the implanted FPFP was determined by comparing to the preoperative image. If a mass of at least greater than 10 mm in the longest diameter was seen as an obvious fat density in the same area that fat was implanted during the operation and was densely adjoined to adjacent tissue, the case was defined as an engrafted case as the fat was considered to have survived to become adherent to the lesion.

Air leak duration in patients assigned to the 2 methods above was analyzed by the Student $t$ test using JMP version 9. The differences were considered statistically significant when the $p$ value was 0.05 or less.

### *Techniques*

When moderate to severe air leaks were detected during the intraoperative sealing test, the following operative technique was carried out. First, pericardial fat was collected by the electric scalpel. The size of collected free pericardial fat depended on the range of the damaged lesion of lung parenchyma that needed to be covered. Suturing the pleura of the lung using FPFP was performed with a half-expanded affected-side lung. To reinforce the stump, the pleural junction was held between the fat. To avoid rupture of the suturing site the fistula was reefed loosely by absorbable line (4-0 PDS II; Ethicon, Somerville, NJ) in anticipation of full lung expansion.

The basic technique of this method is repeated simple ligation so that the junction of the visceral pleura is sandwiched by the collected fat tissue to close and seal the laceration of the lung surface. First, the suture needle with thread was passed from the mediastinal pleural side of the fat. Next, the suture needle was passed through each edge of the laceration of the lung parenchyma with the visceral pleura. Last, the suture needle was passed through the fat from the reverse side, including mediastinal pleura, and the thread was tied loosely taking into account the state of fully expanded lung (Figs 1A and 1B). It is very important that each suture pass through the mediastinal pleura of the fat and the visceral pleura of the lung to maintain the strength of the junction. To treat a lesion with a visceral pleural defect, especially in the delamination area of the hilum, the suture must be passed through the vascular sheath or the bronchial sheath to maintain the strength of the suture technique. When the air leaks disappeared or remained mild or less at the second sealing test this manipulation was finished. However, when moderate or greater air leaks remained, fibrin glue (Beriplast P Combi-Set; CSL Behring Pharma, Tokyo, Japan) was sprayed between the fat and pleura widely to fill up the residual air leak lesion of the interspace to reinforce the sealant (Fig 2).

## Results

A total of 51 cases of lung resection fulfilled the inclusion criterion at the first water sealing test and were enrolled in this study. All intraoperative air leaks were controlled by the new technique with no problems. There were no cases that required conversion to conventional methods and there were no further adverse events. The pericardial fat covering technique was used in 39 cases. In this group, the mean durations of air leaks and chest tube drainage were 1.05 $\pm$ 1.84 days and 3.94 $\pm$ 1.91 days, respectively; PAALs occurred in 1 case. The pericardial fat covering technique combined with fibrin glue was used in 12 cases. In this group, the mean durations of air leaks and chest tube drainage were 2.66 $\pm$ 3.42 days and 5.33 $\pm$ 3.31 days, respectively; PAALs occurred in 2 cases. Follow-up chest CT was performed in all 51 cases, and fat engraftment was confirmed in 32