

Use of Stitching and Bioabsorbable Mesh and Glue to Combat Prolonged Air Leaks



Toshiki Tanaka, MD, PhD, Kazuhiro Ueda, MD, PhD, Junichi Murakami, MD, PhD, and Kimikazu Hamano, MD, PhD

Department of Surgery and Clinical Science, Division of Chest Surgery, Yamaguchi University Graduate School of Medicine, Yamaguchi, Japan

Prolonged postoperative air leaks are associated with extended periods of postoperative hospitalization, increased hospital costs, and increased incidence of major cardiopulmonary complications. To prevent prolonged air leaks, we used small pieces of polyglycolic acid mesh as a pledget during the stitching of air leak sites. The stitched sites were then covered with mesh and fibrin glue. This novel technique showed the highest airway

pressure tolerance in an *ex vivo* experimental study. There were no incidents of prolonged air leak among the five clinical cases in which this technique was initially applied. A large-scale study of patients with a high risk of prolonged air leak is warranted.

(Ann Thorac Surg 2018;106:e215–8)

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Postoperative air leaks are the most frequent pulmonary complication observed after major lung resection for cancer [1]. Prolonged air leak not only leads to extended periods of postoperative hospitalization and increased hospital costs but also to an increased incidence of major cardiopulmonary complications [2, 3]. We used bioabsorbable mesh in combination with fibrin sealant to seal air leaks, which led to reductions in the duration of chest tube drainage and hospitalization and the rate of postoperative cardiopulmonary complications [4]. Chest tubes could be removed by postoperative day 1 in more than 90% of patients who underwent major lung resection for cancer. Recently, on the basis of these results, we omitted postoperative chest tube placement in selected patients who underwent major lung resection without considerable adverse events [5]. However, we simultaneously experienced prolonged air leak (lasting ≥ 7 days) in 5% of the cases [6]. We herein present a new technique for combating prolonged air leaks in which the air leak site is stitched, then covered with bioabsorbable mesh and fibrin glue.

Technique

Stitching and Covering With Bioabsorbable Materials

Air leak sites were stitched by horizontal mattress suturing with the use of 4-0 monofilament absorbable suture thread (PDS II; Ethicon Inc, Somerville, NJ) with the combined use of small pieces (10 × 5 mm in size) of bioabsorbable mesh as pledgets. The stitched sites were

covered with the use of the bioabsorbable mesh and fibrin glue (Beriplast; CSL Behring, Tokyo Japan), as described previously [4] (Fig 1). We used two different types of polyglycolic acid (PGA) mesh (Neoveil; Gunze, Osaka, Japan) as bioabsorbable materials: 0.3-mm-thick PGA mesh was used for pledgets and 0.15-mm-thick PGA mesh was used as a covering sheet.

Chest Tube Management

After sealing any air leakages, 20F chest tube was introduced through one of the ports. The chest tube was removed just after tracheal extubation if no air leakages were detected in a suction-induced air leakage test, which is an original technique to confirm pneumostasis. In patients with any air leakage during the suction-induced air leakage test, a 20F chest tube was placed in the hemithorax postoperatively. Chest tubes were removed the day after the air leakage disappeared, regardless of the amount of pleural drainage [5].

Ex Vivo Experiments

Pig tracheal lung models were used. The visceral pleura with the lung parenchyma was dissected (size, 10 × 10 mm; depth, 5 mm). Three different techniques were used for sealing air leaks: simple stitching without pledgets (group A); stitching with pledgets (group B); and stitching with pledgets, followed by covering with mesh (group C). Fibrin glue was used to ensure that the air leaks were sealed in all groups. After sealing, a tracheal tube was inserted into the trachea and the bursting pressure was measured. As a result, group C showed the highest

Accepted for publication April 15, 2018.

Address correspondence to Dr Ueda, Department of Surgery and Clinical Science, Yamaguchi University Graduate School of Medicine, 1-1-1 Minami-kogushi, Ube, Yamaguchi 755-8505, Japan; email: kaueda@yamaguchi-u.ac.jp.

The Video can be viewed in the online version of this article [<https://doi.org/10.1016/j.athoracsur.2018.04.046>] on <http://www.annalsthoracicsurgery.org>.

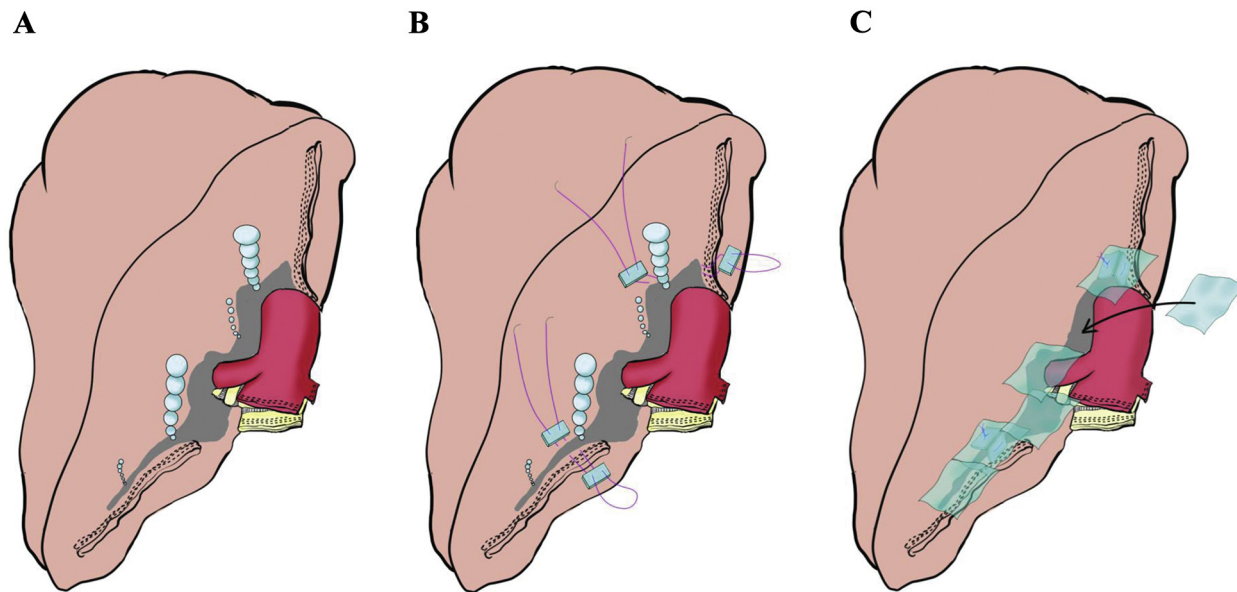


Fig 1. The schematic illustration shows the technique of stitching and covering with bioabsorbable mesh. (A) Several types of air leaks were identified during the water seal test. (B) The major air leak point should be stitched with horizontal mattress sutures using 4-0 bioabsorbable monofilament suture thread with pledgets. (C) After stitching, pieces of mesh soaked in solution A of fibrin glue are placed over the sealing site. Solution B is then sprayed over the surface to create the primary seal.

airway pressure tolerance (C versus A, $p < 0.001$; C versus B, $p = 0.023$) (Fig 2).

Initial Clinical Experience

We applied our novel technique in the treatment of 5 patients who underwent thoracoscopic major lung resection for lung cancer between April 2017 and December 2017. From our previous report [6], these patients were identified as having a high risk of developing prolonged postoperative air leak (emphysema index $\geq 35\%$ on quantitative computed tomography). After a water seal test and the identification of the air leak points, the lung was deflated. The points of the major air leaks were stitched with pledgets. Then, solution A of the fibrin glue, which contains human fibrinogen, human plasma coagulation factor XIII, and bovine aprotinin, was sprayed over the pledgets and the other minor air leak points. After half inflating the lung, small pieces of PGA mesh soaked in solution A were placed over the stitched sites and minor air leak points. Solution B of the fibrin glue, which contained human thrombin, was then sprayed over the surface to create a primary seal. Solutions A and B were sprayed separately over the primary sealing site (Video). As a result, the chest tube could be removed before postoperative day 7 in all 5 patients: the mean length of postoperative chest tube drainage was 3 days (range, 1 to 6 days).

Comment

Pneumostasis with the use of PGA mesh and fibrin glue could seal air leaks intraoperatively in most of the patients who underwent major lung resection [4]; this

reduced the duration of chest tube drainage to 1.5 days [6]. Furthermore, the omission of postoperative chest tube placement was achieved in 37% of patients who underwent major lung resection without remarkable adverse events. However, we still experienced prolonged air leak in 19.4% of patients with an emphysema index of 35% or greater on quantitative computed tomography. In addition, we sometimes experienced massive air leak from a small leak point, especially in patients with severe emphysema because of prominent airway communication in the emphysematous lungs. In such situations, the PGA mesh could be easily peeled off because of massive air leak after the lung was inflated. Thus, we had to implement new measures to prevent such massive air leaks from arising in the hyper-inflated lung.

The current technique, in which the air leak is stitched and covered with bioabsorbable materials, was shown to be more reliable than the other two methods in the experimental study. Suturing techniques that used other reinforcement materials such as a collagen matrix coated with lyophilized human fibrinogen and thrombin [7], or a subcutaneous fat pad [8], may also be helpful for closing air leaks. However, if the dissected area is large, these techniques may be difficult to apply to the whole area. The advantage of our technique is that the entire dissected areas can be sealed by the selective use of mesh covering and stitching with pledgets: massive air leaks should be closed with stitching, whereas small air leaks can be sealed by mesh covering alone. Another advantage is that the placement of a mesh covering over the stitched site can reinforce the suture site, which can prevent the splitting of the fragile emphysematous lung parenchyma because of excessive expansion after lung inflation. The

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