Editorial

How to manage bleeding and air leaks in thoracic surgery

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Intraoperative bleeding and air leaks in thoracic surgery are very distressing. Intraoperative bleeding is a threat to thoracic surgeons if not properly managed, and postoperative air leaks can lead to postoperative complications, prolonged hospital stay, and decreased daily activities for the patient. Thus, learning techniques to avoid such situations, and complications as well as to tackle the occasionally unavoidable instances is important for thoracic surgeons.

With the widespread use of thoracoscopic and robot-assisted surgery in recent years, intraoperative bleeding management and air leak prevention has become well established. For intraoperative bleeding, institutional development and utilizing algorithm for standardized troubleshooting would be useful. The first reason is the possibility of disastrous consequences after an incorrect initial response to bleeding from the pulmonary artery, which has a thin and fragile wall. Additionally, several previous reports have shown that the risk of intraoperative bleeding can occur at a certain rate, regardless of the surgeon's experience (1-3). Our team has suggested compression hemostasis using the lung parenchyma as the first response to bleeding, followed by interventions such as placement of hemostatic sealant, clipping, and suturing (1). Similarly, Cardillo *et al.* reported that the initial response to bleeding should be compression hemostasis, followed by clipping, suturing, and the use of hemostatic agents (4). Although a variety of hemostatic agents have been developed, their availability may be limited by region or by insurance. Thus, we often use a collagen sponge coated with human fibrinogen and thrombin (TachoSil, CSL Behring, Tokyo, Japan), which is a suitable hemostatic agent for low-pressure vessels such as the pulmonary artery. However, TachoSil should not be used for direct hemostasis of high-pressure vessels, such as the subclavian artery, due to the possibility of pseudoaneurysm formation, as reported by Yamashita *et al.* (2).

Based on the opinion of Cardillo and other experts, intraoperative bleeding can affect operative time and drainage management, resulting in longer hospital stay, wound infection, and empyema (4). However, our team reported that the development and proper handling of a troubleshooting algorithm for intraoperative bleeding did not statistically significantly increase the duration of postoperative drainage or hospitalization, and the number of complications (1). Indeed, the formulation of a standardized response to bleeding may be useful. Additionally, the skin incision during thoracotomy should be large enough to allow one hand to enter the thoracic cavity firmly for manual manipulation, which is useful for hemostatic operations in emergency situations. The surgeon should know the size of the skin incision into which his or her hand will fit.

Postoperative air leak is a commonly encountered complication following pulmonary resection and had been reported by Cardillo *et al.* to be the most problematic complication following thoracic surgery (4). Most air leaks resolve spontaneously with proper drainage management

(5,6). However, prolonged air leak (PAL) can sometimes occur and cause trouble by leading to prolonged hospitalization, increased medical costs, and complications such as pneumonia and empyema (5,7-10). Brunelli *et al.* observed 50% higher medical costs and longer hospital stay by four days in patients who had PAL than in those who did not (11). As a result, various efforts are being made to prevent PAL. The fissureless technique had been used in cases of dense fissure and was shown to reduce the rate of PAL in some retrospective reports published by 2010 as well as in more recent prospective reports (12-14). Stamenovic *et al.* demonstrated that when compared with conventional thoracoscopic lobectomy, thoracoscopic fissureless lobectomy resulted in a similar operative time but significantly reduced PAL morbidity in terms of postoperative drainage period and hospital stay (14). Moreover, our team reported the efficacy of thoracoscopic fissureless lobectomy in patients with dense fissures, where we demonstrated equivalent perioperative results, including postoperative drainage time and occurrence rate of PAL, between patients with separated fissures and those with dense fissures (15).

Staple line reinforcement had been reported by some studies to reduce PAL; however, this result should be interpreted with caution. In a meta-analysis of 13 clinical trials on the use of glues, patches, or buttresses on the staple line to avoid air leaks, Malapert *et al.* concluded that the use of a surgical sealant or buttressing can be helpful in reducing PAL following pulmonary resection, although caution should be exercised in terms of publication bias (16). Covering the staple line with a sheet of polyglycolic acid (PGA) is another technique that was reported to significantly reduce the postoperative recurrence of primary pneumothorax and may also be useful in the prevention of PAL following pulmonary resection (17).

Additional techniques, including the use of various sealants such as fibrin glue, synthetic materials, and collagen patches coated with fibrinogen or thrombin, have been employed to minimize the intensity and duration of air leaks (5,6,8,9,16,18). However, evidence on the use of sealants in pulmonary resection had been inconsistent. Moreover, there had been no clear consensus on the optimal use of sealants in air leak management. Recently, Bachmann *et al.* reported the results of a prospective clinical trial that compared PGA sheets and collagen sponges coated with fibrinogen and thrombin for air leaks following open pulmonary resection (19). They showed interesting data that both were effective tools for treating air leaks; however, that the PGA sheet may be more effective in controlling postoperative air leak although the difference was not statistically significant.

Learning the proper management procedures for postoperative complications of bleeding and air leaks, choosing the right material for the situation, and sharing the knowledge will lead to safer thoracic surgery procedures. Additionally, further development of sealants and future large-scale clinical trials are desirable for improving medical technology.

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