complete revascularization of the left ventricle. Ann Thorac Surg 1999; 68(1):131—6.
[2] Trehan N, Mishra M, Sharma OP, Mishra A, Kasliwal RR. Further reduction in stroke after off-pump coronary artery bypass grafting: a 10-year experience. Ann Thorac Surg 2001;72(3):S1026—32.
[3] Watanabe G, Takahashi M, Misaki T, Kotoh K, Doi Y. Beating-heart endoscopic coronary artery surgery. Lancet 1999;354(9196):2131—2.
[4] Karagoz HY, Sonmez B, Bakkaloglu B, Kurtoglu M, Erdinc M, Turkeli A, Bayazit K. Coronary artery bypass grafting in the conscious patient without endotracheal general anesthesia. Ann Thorac Surg 2000;70(1):91—6.
[5] Aybek T, Kessler P, Khan MF, Dogan S, Neidhart G, Moritz A, Wimmer-Greinecker G. Operative techniques in awake coronary artery bypass grafting. J Thorac Cardiovasc Surg 2003;125(6):1394—400.
[6] Kirali K, Koçak T, Güzelmeriç F, Göksedef D, Kayalar N, Yakut C. Off-pump awake coronary revascularization using bilateral internal thoracic arteries. Ann Thorac Surg 2004;78(5):1598—602.
[7] Meininger D, Neidhart G, Bremerich DH, Aybek T, Lischke V, Byhahn C, Kessler P. Coronary artery bypass grafting via sternotomy in conscious patients. World J Surg 2003;27(5):534—8.
[8] Al-Abdullatief M, Wahood A, Al-Shirawi N, Arabi Y, Wahba M, Al-Jumah M, Al-Sheha S, Yamani N. Awake anaesthesia for major thoracic surgical procedures: an observational study. Eur J Cardiothorac Surg 2007;32(2): 346—50.
[9] Karagoz HY, Kurtoglu M, Bakkaloglu B, Sonmez B, Cetintas T, Bayazit K. Coronary artery bypass grafting in the awake patient: three years' experience in 137 patients. J Thorac Cardiovasc Surg 2003;125(6): 1401—4.
[10] Sugawara T, Itoh Y, Hirano Y, Higashiyama N, Shimada Y, Kinouchi H, Mizoi K. Novel dural closure technique using polyglactin acid sheet prevents cerebrospinal fluid leakage after spinal surgery. Neurosurgery 2005;57(4 Suppl.):290—4.
[11] Minato N, Shimokawa T, Katayama Y, Yamada N, Sakaguchi M, Itoh M. New application method of fibrin glue for more effective hemostasis in cardiovascular surgery. Jpn Thorac Cardiovasc Surg 2004;52(8):361—6.
[12] Dresdale A, Bowman FO, Malm JR, Reemtsma K, Smith CR, Spotnitz HM, Rose EA. Hemostatic effectiveness of fibrin glue derived from single-donor fresh frozen plasma. Ann Thorac Surg 1985;40(4):385—7.
[13] Kawamura M, Gika M, Izumi Y, Horinouchi H, Shinya N, Mukai M, Kobayashi K. The sealing effect of fibrin glue against alveolar air leakage evaluated up to 48 h; comparison between different methods of application. Eur J Cardiothorac Surg 2005;28(1):39—42.
[14] Hanks JB, Kjaergard HK, Hollingsbee DA. A comparison of the hemostatic effect of Vivostat patient-derived fibrin sealant with oxidised cellulose (Surgicel) in multiple surgical procedures. Eur Surg Res 2003; 35(5):439—44.
[15] Tateishi J, Kitamoto T, Mohri S, Satoh S, Sato T, Shepherd A, Macnaughton MR. Scrapie removal using Planova virus removal filters. Biologicals 2001;29(1):17—25.
[16] Mineo TC. Epidural anesthesia in awake thoracic surgery. Eur J Cardiothorac Surg 2007;32:13—9.

Editorial comment

Pleural tears: are all holes the same?

Keywords: Pleura; Repair; Polyglycolic acid; Fibrin sealant; Air leak; CABG; Thoracic surgery

Pleural tears are a common occurrence in thoracic surgery and a prolonged air leak is often encountered in patients undergoing lung resection or volume reduction when there is associated emphysema [1]. Spontaneous pneumothorax is closely related to pulmonary blebs and interstitial emphysema resulting in variable collapse of lung tissue [2]. Various sealants and glues are available to repair the pleural defects but the optimal treatment and equally, the management of chest tubes are a matter of controversy [1]. Recently, even endobronchial valves have been inserted to control a persistent air leak [3].

In this manuscript the authors address a very specific category of parietal pleural tears; those occurring during awake coronary artery bypass grafting (CABG) [4]. In their clinical experience respiratory assistance because of pneumothorax was necessary in 15 out of 43 patients (34.9%) with endotracheal intubation required in 2 patients (4.7%). In an experimental setting they developed a promising novel technique based on dural closure, repairing the tear by a so-called 'rub-and-spray method' using polyglycolic acid (PGA) fabric and fibrin glue.

In a thoracic model using rat skin as pleural substitute a burst pressure of 356 mmHg was measured, which is much higher than normal, physiological intrathoracic pressures. Defects up to 50 mm could be repaired. There were no significant differences regarding the application of negative pressure, moisture, time (with measurements up to 3 h), and respiratory movements. However, there was a significant difference regarding the size of the defect; larger defects having lower burst pressures but still high above physiological values.

In a subsequent pig experiment, sternotomy was performed after endotracheal intubation and mechanical ventilation. Pleural defects of different sizes (10 and 30 mm) were created at different locations and subsequently repaired. This was easily achieved with an average duration of only 21 s. Strong closure with sufficient early durability was obtained.

Although these experiments provide valid information, there are several limitations in the models used. The in vitro thoracic substitute the authors describe, is in fact a rigid plastic bottle, which is quite different from the elastic thoracic cage. In this way, no precise physiological conditions can be applied. Rat skin was used as pleural surrogate but histological similarities and differences with normal pleura are not described. No measurements were made beyond 3 h and histological evaluation of the healing process was not performed. Was this accompanied by a lot of inflammation? PGA disintegrates by about 50% in 10 days and it would

be interesting to know what the repair looks like after 2—3 weeks.

In the pig experiment endotracheal intubation and mechanical ventilation were used, conditions not quite similar to awake CABG. Repair was easily obtained but this relates to normal pleura which is fairly different from patients with bullous emphysema, in whom tears of the fragile visceral and parietal pleura easily occur and are much more difficult to repair. Not all holes are the same! Again, there was no histological evaluation of the healing process around the tear.

In awake patients a tear in the parietal pleura may rapidly give rise to a pneumothorax with variable collapse of the lung. From the manuscript it is not clear how the authors would manage the pneumothorax itself, before and after the repair. Would they insert a thoracic drain through a separate incision or perform simple aspiration through the pleural tear before closing it? Which postoperative follow-up do they propose?

Regarding clinical application, which was not yet performed in the present study, PGA mesh with fibrin glue has recently been applied in patients undergoing major pulmonary resection [5]. In a total series of 45 patients, PGA mesh was used in 28 patients to obtain sutureless pneumostasis. Except for one patient, air leak ceased immediately allowing removal of the chest tubes on the first postoperative day.

The use of PGA with fibrin glue is an expensive technique and it is not yet clear whether this can be offset by a reduced hospitalization time. The risk of transmission of infection with the use of fibrin glue can also not be completely eliminated. Alternative methods have recently become available. In a series of 13 patients with persistent posttraumatic pneumothorax good results were obtained by thoracoscopic application of two synthetic polyethylene glycols, which act as a topical sealant [6].

So, although the described technique of PGA mesh with fibrin glue seems promising, further experimental and clinical evaluation is necessary before it can be widely applied in different patient populations with pleural tears and air leaks due to damaged visceral and parietal pleura. The future will tell whether this technique is able to repair different tears and holes in the pleura with long-lasting results.

References

[1] Tambiah J, Rawlins R, Robb D, Treasure T. Can tissue adhesives and glues significantly reduce the incidence and length of postoperative air leaks in patients having lung resections? Interact Cardiovasc Thorac Surg 2007;6:529—33.
[2] Van Schil P, Hendriks J, De Maeseneer M, Lauwers P. Current management of spontaneous pneumothorax. Monaldi Arch Chest Dis 2005;63:204—12.
[3] Toma T, Kon O, Oldfield W, Sanefuji R, Griffiths M, Wells F, Sivasothy S, Dusmet M, Geddes D, Polkey M. Reduction of persistent air leak with endoscopic valve implants. Thorax 2007;62:830—3.
[4] Kato Y, Matsumoto I, Tomita S, Watanabe G. A novel technique to prevent intra-operative pneumothorax in awake coronary artery bypass grafting. Eur J Cardiothorac Surg 2009;35:37—41.
[5] Ueda K, Tanaka T, Jinbo M, Yagi T, Li T, Hamano K. Sutureless pneumostasis using polyglycolic acid mesh as artificial pleura during video-assisted major pulmonary resection. Ann Thorac Surg 2007;84:1858—61.
[6] Carrillo E, Kozloff M, Saridakis A, Bragg S, Levy J. Thoracoscopic application of a topical sealant for the management of persistent posttraumatic pneumothorax. J Trauma 2006;60:111—4.

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Available online 2 October 2008

doi:10.1016/j.ejcts.2008.08.011