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Video-assisted thoracoscopic surgery (VATS) for bilateral primary spontaneous pneumothorax

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Abstract: Objective: To review our experience of the treatment of bilateral primary spontaneous pneumothorax (PSP) by video-assisted thoracoscopic surgery (VATS). Materials and methods: Retrospective chart review was followed by an on-clinic or telephone interview. Patients were cared for by one thoracic surgeon in four medical centers or community hospitals in Northern and Central Taiwan. Thirteen patients with bilateral PSP underwent bilateral VATS simultaneously or sequentially from July 1994 to December 2005. Results: Twelve males and one female, with age ranging from 15 to 36 years (mean 23.1 years), were treated with VATS for bilateral PSP, under the indications of bilateral pneumothoracis simultaneously (n=4) or sequentially (n=9). The interval between the first and second contra-lateral VATS procedure for non-simultaneous PSP patients ranged from 7 d to 6 years. Eleven of 13 patients (84.6%) had prominent pulmonary bullae/blebs, and underwent bullae resection with mechanical or chemical pleurodesis. The mean operative time was (45.6±18.3) min (range 25~96 min) and (120.6±28.7) min (range 84~166 min) respectively for the non-simultaneous (second VATS for the recurrence of contralateral side after first VATS) and simultaneous (bilateral VATS in one operation) procedures. There was no postoperative mortality. However, prolonged air leakage (>7 d) occurred in one patient (7.7%) who recovered after conservative treatment. The mean duration of chest tube drainage was 3.1 d and the median follow up period was 3.4 years. Conclusions: VATS is a safe and effective procedure in the treatment of bilateral PSP. Bilateral VATS is only recommended for patients with simultaneously bilateral PSP, because the incidence of recurrence, even with visible bullae, was not so high in my group and in some previous literature. Bilateral VATS in a supine position should only be used in selective cases, because of possible pleural adhesion or hidden bullae on the posterior side.

Key words: Video-assisted thoracoscopic surgery (VATS), Spontaneous pneumothorax (SP)
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INTRODUCTION

Spontaneous pneumothorax (SP) can be classified as of either the primary or secondary type. The primary spontaneous pneumothorax (PSP), which is defined as a pneumothorax without underlying lung disease, mostly affects young and thin males, and is usually caused by ruptured pleural blebs (Abdala *et al*., 2001). The secondary spontaneous pneumothorax (SSP) usually occurred in aged people and is combined with other pulmonary diseases such as COPD or tuberculosis (Luh *et al*., 2004). SP can occur bilaterally, either simultaneously or sequentially, in around 7.8% to 20% of patients surgically treated for SP (Baumann and Strange, 1997; Ikeda *et al*., 1988; Lang-Lazdunski *et al*., 2003; Liu *et al*., 1999; McCarthy *et al*., 1997; Watanabe *et al*., 2004). There were 54% to 88% of patients with unilateral SP being noted with contralateral bullous disease (Ikeda *et al*., 1988; Sihoe *et al*., 2000; Bertrand *et al*., 1996; Schramel *et al*., 1996).

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has been used for the re-section of bullae since the 1990s, and has gradually become the standard treatment for PSP (Melvin *et al*., 1992; Cardillo *et al*., 2000; Luh *et al*., 2004; Liu *et al*., 1999). Bilateral VATS for patients with simultaneously bilateral PSP is usually indicated. However, its use in cases with non-simultaneously bilateral PSP, which has been advocated in some reported series (Ayed, 2002; Watanabe *et al*., 2004), is still controversial. The aims of this study were to describe our experiences in Taiwan relating to the treatment of 13 patients with simultaneous or non-simultaneous bilateral PSP.

PATIENTS AND METHODS

From July 1, 1994 to Dec. 31, 2005, 162 patients with PSP underwent VATS treatment by one surgeon. Thirteen (8.0%) of them were noted with simultaneously bilateral (*n*=4) or contra-laterally recurrent (*n*=9) PSP. Preoperative investigations included a chest radiograph, blood chemistry and hemogram, and an electrocardiogram. Chest computed tomography (CT) was done for eight of them (Fig.1). Through this procedure we can successfully determined the location(s) of bullae or possible pleural adhesions. Furthermore, contralateral lung parenchymal lesions can also be seen from this procedure.

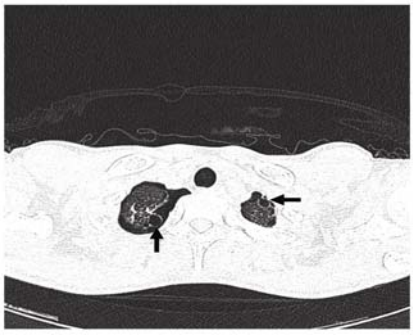

Fig.1 Chest computed tomography (CT) revealed bilateral blebs (arrows) at the apex of the lung

The VATS procedures for PSP were performed with the patient under general anesthesia and double lumen endotracheal ventilation. The patients were placed in a lateral position, with the anterior chest wall being tilted slightly backwards, and the arm was abducted to allow the maximum upward displacement of the scapula. The first 10-mm port was placed in the previous thoracostomy area or the fifth or sixth intercostal space in the mid-axillary line. A 10-mm, 30° end-viewing or 0° operating scope was introduced according to the work needed in the thoracic cavity. Two other working ports were placed in the third or fourth intercostal space in the axillary area and the fifth or sixth intercostal space in the midclavicular (anteriorly) or auscultatory triangle (posteriorly), respectively.

The lung was inspected from the apex to the diaphragmatic area to detect bullae or blebs. If there was pleural adhesion that hampered the subsequent procedure, we would divide it endoscopically by mixed blunt (with the use of peanut or suction tip) and sharp (scissors or electro-cauterization) dissection. Engorged vessels, which sometimes appeared over the adhesion site, were meticulously checked and clipped before division.

The excision was done mostly by using an endoscopic stapler (endo-GIA; Auto-Suture Company, United States Surgical Corporation; Norwalk, CT). Endoscopic suture or loop ligation was used in combination for two patients with multiple and small bullae/blebs, to reduce the costs. These two procedures have been widely applied in our VATS procedures to seal off the air leakage from bullae or other causes of pleural defects (Luh *et al*., 1996; 2004). Then a parietal pleural abrasion by gauze was performed. If the bullae or blebs were not visible, we could check the air leakage area by gently inflating the lung, which was immersed in warm saline. The position of the checking region should be kept on the dependent side in order to successfully perform this procedure. Blinded apical wedge resection would be done if the above procedures failed to discover the bullae/blebs or air-leakage site. A 28 Fr chest tube was inserted through the lower trocar site and connected to an underwater seal suction with a negative pressure of 10~15 cm H_2O.

Patients with simultaneously bilateral PSP (*n*=4), were moved to the opposite lateral decubitus position, and the same procedure was performed on the contralateral side. We did not perform VATS on the side of first attack at the time of contralateral recurrence. That is to say, our treatment guideline from 1994 was that VATS was only performed on the side of PSP at that time, regardless of any past patient histories.

There were only four cases out of these nine patients who first underwent VATS at our clinic, and the other five were referred from other clinics. There were another three patients at our clinic who underwent conservative treatments (observation or tube drainage) only for contralateral recurrence and another one patient underwent VATS at other clinic. Thus the estimated contralateral recurrence rate among our follow up patients was 5.1% (8/158).

All patients were extubated immediately after operation. Analgesics with intramuscular meperidine and/or non-steroid anti-inflammatory drug (NSAID) were administered every 4 to 6 h according to patient request. Oral analgesics were administered later as needed. The intercostal drain was removed when the lung was fully expanded with no air leakage and less than 100 ml of pleural fluid drained in 24 h. In recent years we avoided the use of NSAIDs for patients undergoing pleurodesis because this might reduce the effectiveness of pleurodesis (Hunt *et al*., 2007). Patients were discharged the day of or after the removal of the chest tube.

Data from these patients was collected, including the events of pneumothorax, the operation procedure, the interval between the first and second VATS (non-simultaneous PSP), the operative findings, and the operative time, plus data relating to the pleural drainage amount and duration, the amounts of analgesics administered in the first 24 h after operation, length of hospital stay, postoperative complications, and the follow up status. Patients were followed up during a visit to a clinic or by telephone interview. The requested doses of analgesia were collected from the nursing record. Continuous variables were expressed as the mean±*SD* or median with ranges of data, and this data was analyzed by the Mann-Whitney-Wilcoxon test. Categorical variables were analyzed by the Chi-square or Fisher exact test. The *P*-value <0.05 was considered statistically significant.

RESULTS

The clinical data of these thirteen patients (12 males, 1 female) are summarized in Table 1. The ages ranged from 15 to 36 years (mean 23.1 years). The interval between the first and second contralateral VATS procedures for non-simultaneous PSP patients (n=9) ranged from 7 d to 6 years. Bilateral VATS in the bilateral decubitus position was performed for

Table 1 Clinical data and treatment results of thirteen patients with bilateral PSP treated by simultaneous or non-simultaneous VATS

	Simultaneous bilateral PSP (n=4)	Non-simultaneous bilateral PSP (n=9)
Mean age (years)	22.1 (range 15~27)	24.3 (range 17~36)
Gender, n_{male}/n_{female}	4/0	8/1
VATS procedure (side)		
1st	$n_{bilateral}$=4	n_{right}:n_{left}=5:4
2nd	–	n_{right}:n_{left}=4:5
Pleurodesis		
Mechanical[1]	n=4	n=9
Chemical[2]	n=3 (75%)	n=6 (67%)
Median interval between 1st and 2nd VATS	–	3.4 years (7 d to 6 years)
Pathology		
Bullae/Blebs present*	n=4 (100%)	n=7 (77.8%)
Mean operational time (min)	120.6±28.7 (range 84~166)	45.6±18.3 (range 25~96)[3]
Analgesia (meperidine) in 24 h median dose (mg)*	150 (range 100~200)	111 (range 0~200)
Mean chest tube duration (d)	4.1 (range 3~10)	3.2 (range 2~6)
Mean hospital stay (d)*	6.3 (range 5~11)	4.5 (range 3~7)
Complications	n=1 (prolonged air-leakage)	Nil
Follow up period (years)	3.8 (range 2~8.6)	3.2 (range 0.5~10)
Status	One with minor recurrence; recovered spontaneously	All were satisfactory

[1]Mechanical pleurodesis: By gauze abrasion in VATS; [2]Chemical pleurodesis: By minocycline intrapleural instillation; [3]Performed unilateral VATS (2nd contralateral occurrence) procedure; *P<0.05

patients with simultaneously bilateral PSP, and sequential VATS was performed for patients with non-simultaneously bilateral PSP at the time of attack. Ten (76.9%) patients had experience of repeated attacks of SP before the first VATS procedures. The other three (23.1%) patients were indicated for VATS because of persistent air leakage (>7 d) at the first attack. Differences of clinical data between the simultaneous and non-simultaneous bilateral PSP groups were insignificant.

Subpleural blebs or bullae were present in all but two cases (11/13, 84.6%), and these were treated by stapling with endo-GIAs. Mechanical (gauze abrasion) and/or chemical (minocycline intrapleural instillation) pleurodesis was added in all patients (Fig.2). The mean operative time was (45.6±18.3) min (range 25~96 min) and (120.6±28.7) min (range 84~166 min) respectively for the non-simultaneous and simultaneous (bilateral VATS in one operation) procedures. There was no postoperative mortality. However, prolonged air-leakage (>7 d) after VATS was found in one patient (7.7%) and this was recovered after conservative treatment. The mean duration of chest tube drainage was (3.1±1.8) d (range 2~7 d). The median follow up period was 3.4 years (range 0.5~10 years). During the follow-up period, one patient was found to have a minor recurrence and recovered spontaneously after bed resting. The others were satisfied with their treatment without recurrence of pneumothorax during the follow-up period. Differences in the treatment profiles and outcomes between patients with simultaneous and non-simultaneous PSP were significant in the dose of analgesia at the early postoperative period and the duration of hospital stay. Bilateral VATS caused more wound pain and a longer hospital stay.

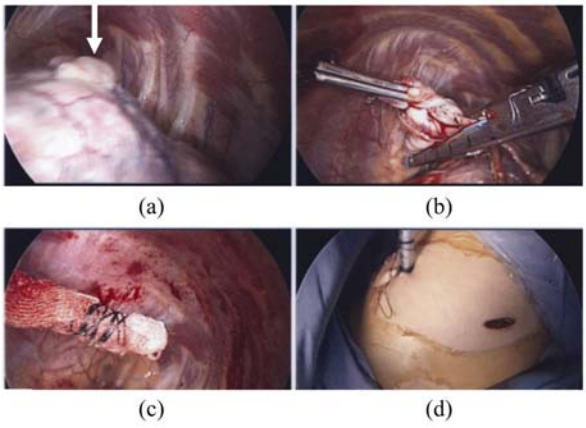

Fig.2 VATS bullectomy and pleurodesis for spontaneous pneumothorax. (a) Bullae over apex of the lung (arrow); (b) Bullectomy with endo-GIA stapling; (c) Mechanical pleurodesis with a gauze-packed long hemostatic clamp; (d) Wounds of the VATS procedure

DISCUSSION

At present VATS has gradually become the preferred procedure for most PSP and some SSP on account of much better treatment effects and a lower recurrence rate when compared with tube drainage or aspiration, as well as its minimal invasiveness compared with open thoracotomy (Hatz *et al*., 2000; Luh *et al*., 2007; Loubani and Lynch, 2000). Therefore, VATS for SP will not only reduce morbidity but also in the long run have a net effect on costs (Hatz *et al*., 2000; Casadio *et al*., 2002). We began to perform VATS for PSP in 1994. Good results were obtained in terms of less postoperative pain, a short hospital stay and a low recurrence rate (Luh *et al*., 2004).

There is more and more evidence to show that VATS is also the choice of procedure for patients with recurrent SP. As to extending the indication for immediate VATS intervention to patients presenting their first episode of SP, this is feasible with surgeons familiar with this procedure (Hatz *et al*., 2000; Torresini *et al*., 2001; Connolly *et al*., 2002). Nearly half of patients with first-time SP at some time require an operation either because of the persistent air leakage or later recurrence (Schoenenberger *et al*., 1991). Thus, chest CT evaluation is valuable because VATS for patients with a first-attack SP will be more strongly indicated if bullae or blebs are visible.

Since a high incidence of bullae or blebs detection was noted in first-onset or recurrent SP in this series and previous literature (Bertrand *et al*., 1996; Ikeda *et al*., 1988; Schramel *et al*., 1996; Sihoe *et al*., 2000), some authors advocated performing bilateral VATS for simultaneous or non-simultaneous SP according to the chest CT findings or previous history of SP (Ayed, 2002; Sihoe *et al*., 2000). In this series this leaves nothing to be debated for bilateral VATS for simultaneous bilateral SP. However, we will not perform bilateral VATS for unilateral SP even if the chest CT showed visible bullae on the contralateral

side or SP with contralateral recurrence. We think that VATS is still an invasive and costly surgical procedure for SP. Moreover, the possibility of contralateral recurrence in my series was very low (5.1%). Furthermore, contralateral recurrence of SP is usually not life-threatening and some of them can be treated conservatively. Thus bilateral VATS for non-simultaneous SP can only provide minimal benefits (reduce recurrence) at the cost of higher operative risk, longer postoperative recovery, more pain and suffering to the patients, as well as a higher operation cost (especially endo-GIA, which is very expensive here) and in-patient hospital costs.

There were no peri-operative deaths in this series. Only one patient (7.7%) showed a prolonged air-leakage (>7 d) postoperatively. Air-leakage at the stapling site or missed bullae/blebs might be the causes. He recovered after conservative care. Previous reports showed 16% to 20% of patients having a prolonged air-leakage and some of them requiring reoperation (Ayed, 2002; Lang-Lazdunski *et al*., 2003).

Some reported series performed bilateral VATS in the supine position for SP (Huang *et al*., 2005; Watanabe *et al*., 2004). My series has some experiences of VATS procedures in the supine position, for SP as well as other types of diseases, such as empyema, emphysema, interstitial lung diseases or pulmonary nodular lesions (Luh and Liu, 2006; Luh *et al*., 2004; 2005). Consideration of the supine position for VATS usually depends on the condition of patients and the location of the lesions. Patients would be selected who cannot tolerate the decubitus position or where the location of lesions can be easily approached by the supine position, since patients with PSP are usually young with a normal pulmonary function and the bullae or blebs are usually located at the apical area, in which the posterior aspect is difficult to check thoracoscopically in the supine position. Moreover, there are usually dense adhesions with engorged vessels from the parietal pleura over this area for patients with recurrent PSPs. Thus, bilateral VATS for PSP in the supine position is generally not necessary and should be selected very carefully.

Obliteration of the pleural space to prevent recurrence of SP can be accomplished by parietal pleurectomy, talc powder spray, chemical or mechanical pleurodesis. Mechanical abrasion with the use of gauze packed instrument has proved to be effective in preventing pneumothorax recurrence. Other reported series and our previous study recommend the use of additional tetracycline pleurodesis (Luh *et al*., 1996; Loubani and Lynch, 2000; Chen *et al*., 2004). At the present time I prefer to use mechanical abrasion only or combined with minocycline intrapleural instillation as the pleural obliteration procedure for SP.

CONCLUSION

In conclusion, VATS is a safe and effective procedure in the treatment of bilateral PSP. Bilateral VATS is only recommended for patients with simultaneously bilateral PSP, because the incidence of recurrence, even with visible bullae, was only about 5% in my group and some previous literature. Bilateral VATS in the supine position should be only used in selective cases because of possible pleural adhesion or hidden bullae on the posterior side.

References

Abdala, O.A., Levy, R.R., Bibiloni, R.H., Viso, H.D., de Souza, M., Satler, V.H., 2001. Advantages of video assisted thoracic surgery in the treatment of spontaneous pneumothorax. *Medicina*, **61**:157-160.

Ayed, A.K., 2002. Bilateral video-assisted thoracoscopic surgery for bilateral spontaneous pneumothorax. *Chest*, **122**(6):2234-2237. [doi:10.1378/chest.122.6.2234]

Baumann, M.H., Strange, C., 1997. Treatment of spontaneous pneumothorax: a more aggressive approach? *Chest*, **112**(3):789-804. [doi:10.1378/chest.112.3.789]

Bertrand, P.C., Regnard, J.F., Spaggiari, L., 1996. Immediate and long-term results after surgical treatment of primary spontaneous pneumothorax by VATS. *Ann. Thorac. Surg.*, **61**(6):1641-1645. [doi:10.1016/0003-4975(96)00190-7]

Cardillo, G., Facciolo, F., Glunti, R., Gasparri, R., Lopergolo, M., Orsetti, R., Martelli, M., 2000. Videothoracoscopic treatment of primary spontaneous pneumothorax: a 6-year experience. *Ann. Thorac. Surg.*, **69**(2):357-362. [doi:10.1016/S0003-4975(99)01299-0]

Casadio, C., Rena, O., Giobbe, R., Rigoni, R., Maggi, G., Oliaro, A., 2002. Stapler blebectomy and pleural abrasion by video-assisted thoracoscopy for spontaneous pneumothorax. *J. Cardiovasc. Surg.*, **43**:259-262.

Chen, J.S., Hsu, H.H., Kuo, S.W., Tsai, P.R., Chen, R.J., Lee, J.M., Lee, Y.C., 2004. Effects of additional minocycline pleurodesis after thoracoscopic procedures for primary spontaneous pneumothorax. *Chest*, **125**(1):50-55. [doi:10.1378/chest.125.1.50]

Connolly, S.S., Hurson, C., Lynch, V., 2002. Thoracoscopic management of primary spontaneous pneumothorax. *Irish. J. Med. Sci.*, **17**:71-72.

Hatz, R.A., Kaps, M.F., Meimarakis, G., Meimarakis, G., Loehe, F., Müller, C., Fürst, H., 2000. Long-term results after video-assisted thoracoscopic surgery for first time and recurrent spontaneous pneumothorax. *Ann. Thorac. Surg.*, **70**(1):253-257. [doi:10.1016/S0003-4975(00)01411-9]

Huang, P.M., Chang, Y.L., Hsu, H.H., Chen, J.S., Lee, J.M., Lee, Y.C., 2005. Supine position with alternating inflation pneumatic cuffs in video-assisted thoracoscopic surgery for bilateral pneumothorax. *J. Thorac. Cardiovasc. Surg.*, **129**(2):437-439. [doi:10.1016/j.jtcvs.2004.06.004]

Hunt, I., The, E., Southon, R., Treasure, T., 2007. Using non-steroidal anti-inflammatory drugs (NSAIDs) following pleurodesis *Interact. Cardiovasc. Thorac. Surg.*, **6**:102-104.

Ikeda, M., Uno, A., Yamane, Y., Hagiwara, N., 1988. Median sternotomy with bilateral bullous resection for unilateral spontaneous pneumothorax, with special reference to operative indications. *J. Thorac. Cardiovasc. Surg.*, **96**(4):615-620.

Lang-Lazdunski, L., Chapuis, O., Bonnet, P.M., Pons, F., Jancovici, R., 2003. Videothoracoscopic bleb excision and pleural abrasion for the treatment of primary spontaneous pneumothorax: long-term results. *Ann. Thorac. Surg.*, **75**(3):960-965. [doi:10.1016/S0003-4975(02)04544-7]

Liu, H.P., Yim, A.P., Izzat, M.B., Lin, P.J., Chang, C.H., 1999. Thoracoscopic surgery for spontaneous pneumothorax. *World J. Surg.*, **23**(11):1133-1136. [doi:10.1007/s002689900636]

Loubani, M., Lynch, V., 2000. Video assisted thoracoscopic bullectomy and acromycin pleurodesis: an effective treatment for spontaneous pneumothorax. *Resp. Med.*, **94**(9):888-890. [doi:10.1053/rmed.2000.0862]

Luh, S.P., Liu, H.P., 2006. Video-assisted thoracic surgery—the past, present status and the future. *J. Zhejiang Univ. Sci. B*, **7**(2):118-128. [doi:10.1631/jzus.2006.B0118]

Luh, S.P., Lee, Y.C., Lee, J.M., Lee, C.J., 1996. Videothoracoscopic treatment of spontaneous pneumothorax. *Int. Surg.*, **81**:336-338.

Luh, S.P., Tsai, T.P., Chou, M.C., Yang, P.C., Lee, C.J., 2004. Video-assisted thoracic surgery for spontaneous pneumothorax: outcome of 189 cases. *Int. Surg.*, **89**:185-189.

Luh, S.P., Chou, M.C., Wang, L.S., Chen, J.Y., Tsai, T.P., 2005. Video-assisted thoracoscopic surgery in the treatment of complicated parapneumonic effusions or empyemas, outcome of 234 patients. *Chest*, **127**(4):1427-1432. [doi:10.1378/chest.127.4.1427]

Luh, S.P., Wu, T.C., Wang, Y.T., Tsao, T.C., Chen, J.Y., 2007. Experiences and benefits of positron emitted tomography-computed tomography (PET-CT) combined with video-assisted thoracoscopic surgery (VATS) in the diagnosis of Stage 1 sarcoidosis. *J. Zhejiang Univ. Sci. B*, **8**(6):410-415. [doi:10.1631/jzus.2007.B0410]

McCarthy, J.F., Lannon, D., McKenna, S., Wood, A.E., 1997. Video-assisted thoracic surgery (VATS) for spontaneous pneumothorax. *Ir. J. Med. Sci.*, **166**:217-219.

Melvin, W.S., Krasna, M.J., McLaughlin, J.S., 1992. Thoracoscopic management of spontaneous pneumothorax. *Chest*, **102**(6):1877-1879. [doi:10.1378/chest.102.6.1877]

Schoenenberger, R.A., Haefeli, W.E., Weiss, P., Ritz, R.F., 1991. Timing of invasive procedure in therapy for primary and secondary spontaneous pneumothorax. *Arch. Surg.*, **126**:764-766.

Schramel, F.M., Sutedja, T.G., Braber, J.C., van Mourik, J.C., Postmus, P.E., 1996. Cost-effectiveness of video-assisted thoracoscopic surgery versus conservative treatment for first time or recurrent spontaneous pneumothorax. *Eur. Respir. J.*, **9**(9):1821-1825. [doi:10.1183/09031936.96.09091821]

Sihoe, A.D., Yim, A.P., Lee, T.W., Wan, S., Yuen, E.H., Wan, I.Y., Arifi, A.A., 2000. Can CT scanning be used to select patients with unilateral primary spontaneous pneumothorax for bilateral surgery? *Chest*, **118**(2):380-383. [doi:10.1378/chest.118.2.380]

Torresini, G., Vaccarili, M., Divisi, D., Crisci, R., 2001. Is video-assisted thoracic surgery justified at first spontaneous pneumothorax? *Eur. J. Cardio-Thorac. Surg.*, **20**(1):42-45. [doi:10.1016/S1010-7940(01)00679-0]

Watanabe, S., Sakasegawa, K., Kariatsumari, K., Suehiro, S., Kudama, T., Shimokawa, S., Sakata, R., 2004. Bilateral video-assisted thoracoscopic surgery in the supine position for primary spontaneous pneumothorax. *Thorac. Cardiovasc. Surg.*, **52**(1):42-44. [doi:10.1055/s-2004-815800]