ORIGINAL ARTICLE

Pleuroscopy: our initial experience in Hong Kong

CME

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Objective To report our preliminary experience using pleuroscopy for patients with pleural diseases.

Design Prospective cohort study.

Setting Tertiary referral hospital with service input from respiratory physicians and cardiothoracic surgeons in Hong Kong.

Patients Between April and November 2007, patients with undiagnosed exudative pleural effusions and proven malignant pleural effusions were recruited for diagnostic evaluations and therapeutic interventions, respectively.

Intervention Pleuroscopy with a semi-rigid thoracoscope performed under local anaesthesia and conscious sedation.

Results A total of 20 patients (16 males and 4 females; mean age, 63 years) underwent the procedure and were followed up for a mean of 19 weeks. For the 14 patients having diagnostic pleuroscopy, the yield was 79% (11 patients). The 3-month success rate for the six patients undergoing pleurodesis was 83% (five patients). Complications were mild and included self-limiting fever (20%, four patients) and localised subcutaneous emphysema (20%, four patients). No major complications or mortality were noted.

Conclusion Pleuroscopy using a semi-rigid instrument is a safe and efficacious procedure for the management of pleural diseases in suitable patients.

Introduction

Pleural tapping, together with closed pleural biopsy, has been the usual initial investigation for pleural effusion. However, about 20 to 25% of exudative pleural effusions remain undiagnosed even after repeated procedures,[1] and in whom video-assisted thoracic surgery (VATS) is usually the next step. Regrettably, not all patients are fit for general anaesthesia and the procedure is relatively more invasive and expensive. Consequently, there has been growing interest in pleuroscopy, performed under local anaesthesia, which usually requires only one port of entry.[2] The procedure enables inspection of the pleural cavity and allows diagnostic pleural biopsy as well as therapeutic talc pleurodesis to be performed under direct visual guidance in a sedated, though spontaneously, breathing patient.[3]

Instead of utilising rigid instruments that were used in the past,[4-7] the recently introduced semi-rigid pleuroscope[8,9] offers advantages similar to those of the flexible fibreoptic bronchoscope (FOB), whilst also being compatible with standard accessories, processors, and light sources for FOB. At this juncture, the procedure is still not very popular among pulmonologists and local experience is lacking. This prospective study reports the initial local experience of pleuroscopy in Hong Kong and evaluates its diagnostic efficacy and safety.

Methods

The study was carried out prospectively in Queen Elizabeth Hospital, a tertiary referral centre with thoraco-surgical support, between April 2007 and November 2007. The procedure was registered with the Hospital Authority Mechanism for the Safe Introduction of the New Procedures/Technology in April 2007. The study received approval by Research Ethics Committee (Kowloon East/ Kowloon Central) and all patients gave prior written informed consent. All the procedures were carried out by a group of four respiratory specialists with training or appropriate experience. Thoracic surgeons were informed of the procedures and could be called in when necessary.

Key words
Pleural diseases; Pleural effusion; Safety; Thoracoscopy

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FIG 1. Semi-rigid thoracoscope with a two-way deflectable tip

內科胸腔鏡術在香港臨床應用的初步經驗

目的 報告本院應用內科胸腔鏡術於診斷及治療患有胸膜症的病人的初步經驗。

設計 前瞻性隊列研究。

安排 香港一所擁有胸肺內科及外科的三級轉介醫院。

患者 在2007年4月至11月期間，患有原因不明的胸腔積液或惡性肺積水而在本院接受診斷及治療的病人。

療法 在病人接受局部麻醉及適量鎮靜劑後，以半剛性胸腔鏡進行內科胸鏡術。

結果 共20人（16男4女）接受手術，病人平均年齡63歲，平均隨訪期19週。14位患有原因不明的胸腔積液的病人中，11人(79%)的病因在術後得以查明。另6位病人接受了胸膜固定術，3個月的成功率為83%（5人）。所有的不良反應都極為輕微，包括自限性發熱（4人，20%）及局部性皮下充氣（4人，20%），並沒有發生任何嚴重的不良反應或死亡。

結論 在適合的病人中，以半剛性胸腔鏡進行的內科胸腔鏡術可以安全及有效地用於治療各種胸膜疾病。

All consecutive patients who had undergone pleuroscopy during the study period were included. The two main indications were: (1) undiagnosed exudative pleural effusions after one or more than one closed pleural biopsy and pleural tapping, and (2) proven malignant pleural effusions for pleurodesis. Patients with the following conditions were excluded: (1) para-pneumonic effusion or empyema, (2) pulmonary embolism, (3) pulmonary fibrosis, (4) unstable cardiopulmonary status, and (5) respiratory failure requiring mechanical ventilation.

The semi-rigid autoclavable instrument (LTF-160, Olympus, Tokyo, Japan) has a total length of 52 cm, and is made up of a handle and a shaft of 27 cm. The latter contains two parts: a 22-cm proximal rigid portion and 5-cm flexible distal end (Fig 1). The two-way deflectable tip is similar to that of a FOB, allowing a 160°-up/130°-down angulation in one plane. The 2.8-mm working channel can accommodate biopsy forceps, brush cytology and spray catheters, and various other electrosurgical instruments. It was interfaced with our pre-existing processor (CV-160, Olympus) and light source (CLV-U40, Olympus) for flexible bronchoscopy.

All patients underwent preliminary blood tests (complete blood picture, liver and renal function, clotting profile, and arterial blood gas), as well as an electrocardiogram and echocardiography to exclude any underlying serious cardiac problems. The amount of the effusion, presence and degree of loculations, and the optimal site for entry were delineated with the help of pre-procedural contrast computed tomography (CT) of thorax and thoracic ultrasonography (USG).

As the service was commenced in April 2007, all the procedures were performed in the operating theatre using full aseptic techniques with the patient under conscious sedation, achieved by titration of intravenous midazolam and fentanyl. Blood pressure, pulse rate, cardiac rhythm, and transcutaneous oxygen saturation were monitored continuously throughout the whole procedure and all patients received supplemental oxygen via nasal cannulae. In the initial phase, monitoring and administration of medications was performed by anaesthetists. Subsequently, the task was taken over by nurses, akin to the usual practice in the bronchoscopy suite. Eventually the procedure was performed in the bronchoscopy suite, after its safety and feasibility was established.

During the procedure, the patients were kept in the lateral decubitus position with the affected side upper most. The portal of entry was usually at the mid-axillary line between fourth and sixth intercostal spaces. Local anaesthesia (2% lignocaine) was administered to the skin, subcutaneous tissue, muscle, and parietal pleura. A 1- to 2-cm skin incision was made with a scalpel, which was followed by blunt dissection of the intercostal muscles until the pleural space was reached. A disposable flexible trocar (Olympus) of inner diameter of 8 mm was inserted through the chest wall. Pleural fluid was then aspirated while air was allowed to enter the pleural space. If the pleural effusion was not massive, the patient was

TABLE 1. Demographic and clinical features of the 20 patients undergoing pleuroscopy

Variable	Values*
Mean (SD) age (years)	62.6 (13.4)
Sex	
Male	16 (80%)
Female	4 (20%)
Current or previous smoker	10 (50%)
Presenting symptoms	
Dyspnoea	12 (60%)
Fever	6 (30%)
Weight loss	5 (25%)
Pleuritic chest pain	5 (25%)
Performance status	
ECOG 1†	8 (40%)
ECOG 2	10 (50%)
ECOG 3	2 (10%)
Extent of effusion	
1/3 hemithorax	4 (20%)
2/3 hemithorax	8 (40%)
Massive	8 (40%)
Pleural abnormalities‡	6 (30%)
Loculations‡	4 (20%)

* Data are shown as No. of patients, unless otherwise stated
† ECOG denotes Eastern Cooperative Oncology Group
‡ Shown on computed tomographs

asked to take occasional deep breaths after trocar insertion, in order to facilitate lung collapse.

Thorough examination of the pleural cavity was then undertaken by inserting the scope through the trocar. Pleural biopsy samples were obtained from the parietal pleura with biopsy forceps, particularly where it appeared abnormal. At least six biopsies were taken from each patient. In patients with known malignant pleural effusion for whom pleurodesis was performed, 4 g of sterile talc (Novatech, La Ciotat, France) was introduced into the pleural cavity with a special insufflator. To achieve a satisfactory and uniform distribution of talc over the pleural surfaces, at intervals pleuroscopic inspections were made during the process. A 24-Fr chest tube was introduced via the entry site at the end of the procedure, and suction of 2 kPa was applied thereafter to facilitate drainage and lung re-expansion.

A chest X-ray was subsequently taken to monitor re-expansion of the lung and check the position of chest tube, which was removed as soon as full lung expansion was achieved. Post-procedural analgesia (on an as-needed basis) was achieved by administration of parenteral tramadol and/or oral dextropropoxyphene, and assessed via patient responses to a visual analogue scale (VAS). Responses were obtained immediately after the procedure when the patient was fully awake after the effects of sedation; they ranged from 1 to 10, with 10 being the highest degree of pain. Patients were discharged once the chest drains were removed, and followed up with chest radiographs at 1, 2, 4, 12 weeks after discharge, and half yearly thereafter for at least 2 years.

Data collected included patient demographics, clinical symptoms, smoking history, general health status (based on the Eastern Cooperative Oncology Group performance status), pain score measured by VAS, radiological appearance, thoracoscopic findings, pleural biopsy results, complications, duration of procedure, duration of chest drainage, and length of stay after procedure. Adverse events or complications were classified as major or minor, according to those described in the literature.[7,10] The data were analysed using the Statistical Package for the Social Sciences (Windows version 11.5; SPSS Inc, Chicago [IL], US), and expressed as either mean (standard deviation [SD]) or median (interquartile range).

Results

Twenty patients with pleural effusions underwent pleuroscopy between April and November 2007 (Table 1). Fourteen (70%) had exudative pleural effusions of unknown origin for which the procedure was for diagnostic purposes. The other six (30%) had malignant pleural effusions newly diagnosed by thoracentesis, and underwent the procedure for therapeutic pleurodesis. Dyspnoea (60%) and fever (30%) were the most frequently presenting symptoms. Sixteen (80%) patients presented with effusions of more than one third of the hemithorax, and two (10%) already had chest drains inserted before pleuroscopy. The mean (SD) follow-up period of these patients was 19 (10) weeks.

In the 14 patients having diagnostic procedures, a diagnosis was obtained in 11 (79%). In all these cases, abnormalities were identified in the pleural cavity, usually in the form of localised or diffuse nodularities. Five malignant effusions were diagnosed—three patients had bronchial carcinoma, one a mesothelioma, and one a carcinoma of stomach which had metastasised to the pleura. Six patients were found to have non-malignant pathology, five of whom had tuberculosis (TB) and one lupus serositis. Localised deposits were found in three (27%) out of the 11 patients with malignancy (Fig 2), while diffuse fine nodularities, sometimes described as "sago nodules",[3] were noted in all five cases diagnosed as TB via the procedure (Fig 3). Three (21%) patients had effusions which remained undiagnosed, even after pleuroscopy. Pleural biopsies of satisfactory quality could not be obtained in one of these three patients, owing to extensive adhesions resulting in suboptimal lung collapse. It was noted that no

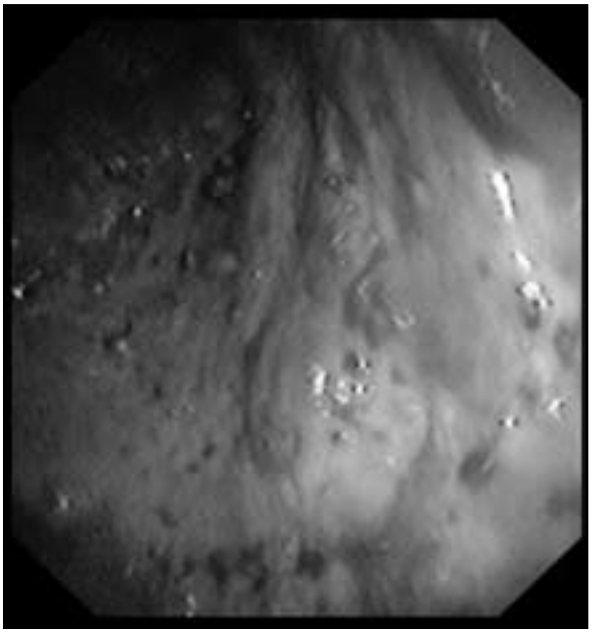

FIG 2. Multiple pleural deposits in a patient with adenocarcinoma of lung

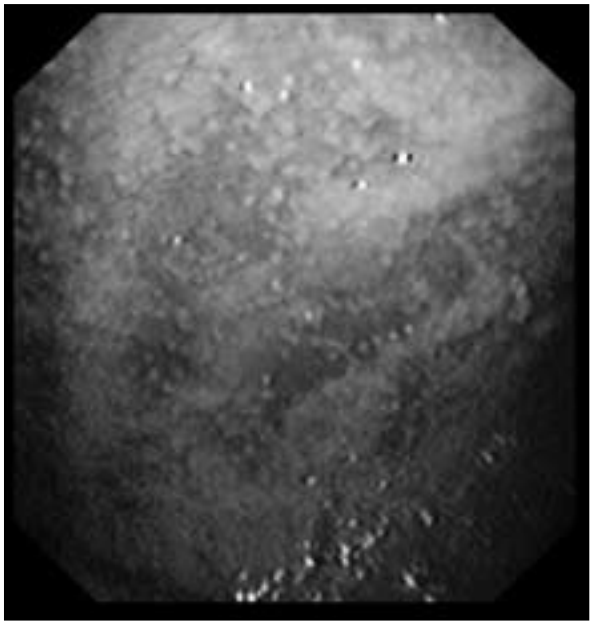

FIG 3. Typical 'sago-like' nodules in a patient with tuberculous pleuritis

septations or loculation were detected as a result of preoperative CT and USG thorax. However, a subsequent ultrasound-guided closed pleural biopsy from a loculated pleural effusion revealed a diagnosis of TB. The other two had normal-looking parietal pleurae during inspection and subsequent biopsies revealed no significant pathologies, and no definite diagnoses were established till submission of this paper. However, in both patients there was no re-accumulation of pleural effusion after the fluid was removed (by pleuroscopy). As only antibiotics had been prescribed for these patients, parapneumonic pleural effusions were considered to be the possible cause. In the six patients with proven malignant effusions, the 3-month success rate of talc pleurodesis was 83% (five patients). Presence of 'trapped lung' after removal of pleural fluid was the reason for failure in one patient who had a lung carcinoma.

The procedural details are shown in Table 2. Fever (20%) and subcutaneous emphysema (20%) were the observed minor complications, and resolved completely within 2 days. Two (10%) patients with carcinoma of lung had 'trapped lung' that failed to expand fully after the procedure and removal of pleural effusions, despite prolonged chest drainage and application of suction. No major complications were observed. Peri-operative and 30-day mortality was 0%.

TABLE 2. The procedural details, outcomes, and safety of pleuroscopy

Variable	Values
Mean (SD) duration of procedure (minutes)	35.9 (8.8)
Mean (SD) duration of subsequent chest drainage (days)	3.6 (3.3)
Mean (SD) length of stay after procedure (days)	7.4 (5.3)
Median (IQR) pain score (visual analogue scale score, 1-10)	3.5 (2-5)
Mean (SD) dose of midazolam (mg)	1.08 (0.65)
Mean (SD) dose of fentanyl (mg)	62.3 (33.5)
Complications, No. of patients (%)	
Major	
Persistent air leakage	2 (10)
Minor	
Fever	4 (20)
Subcutaneous emphysema	4 (20)
Mortality at 30 days	0 (0)

Discussion

Exudative pleural effusion is a common clinical condition encountered in daily practice. Cytological examination of pleural fluid obtained from thoracentesis, which is the usual initial diagnostic step, is only positive in around 60% of patients with malignant pleural effusion and in less than 20% of those with mesothelioma.[11] Additional closed pleural biopsy can increase the diagnostic yield in malignancy by only about 10%, because pleural metastases often locate at sites that are inaccessible.[12] In contrast, the diagnostic yield in tuberculous pleuritis is higher (around 75%).[13] Although repeated procedures might offer a higher diagnostic yield,[14] thoracoscopy by VATS under general anaesthesia is currently the procedure of choice.

First described and performed by Jacobaeus in 1910,[15] thoracoscopy was initially performed to explore the pleural space and to lyse the pleural effusions due to pulmonary TB, to create an artificial pneumothorax as a form of treatment for TB. Although such interventions are no longer popular after the advent of effective anti-TB drugs, recent rapid development of VATS has enabled thoracic surgeons to perform diagnostic and therapeutic thoracoscopies instead of resorting to thoracotomy, which is a more invasive surgical procedure. Thoracoscopy has also been performed under local anaesthesia, especially by respiratory physicians and is known as 'pleuroscopy' or 'medical thoracoscopy'.[4,7] Notably, this approach was more popular in Europe than in the United States or the United Kingdom,[4,16,17] and had never been reported or widely practised in Hong Kong. Apart from offering a relatively non-invasive alternative to patients who are not fit for or refuse general anaesthesia, pleuroscopy is a relatively simple and low-cost investigation,[5] that can be readily performed in a bronchoscopy suite.[9,10,18] International guidelines have even suggested that pleuroscopy is an investigation of choice for undiagnosed pleural effusions.[19]

In the past, medical thoracoscopy was mostly performed with rigid instruments,[20-23] that might have been considered relatively invasive in the setting of local anaesthesia and conscious sedation. Moreover, without addition of an extra entry port, the posterior and mediastinal aspects of the hemithorax are difficult to access using a rigid thoracoscope, especially when a lung was only partially collapsed.[24] Furthermore, most respiratory physicians are not familiar with rigid instruments and hence the procedure was not popular.[16] Using a FOB for the purpose of thoracoscopy has been explored, but despite providing better views at the apex and paravertebral gutters, it was difficult to control and the diagnostic yield was low.[25,26] The recently introduced semi-rigid thoracoscope has been designed to combine the flexibility of the conventional bronchoscope and the rigidity of the conventional thoracoscope. Having a similar design to the FOB, it was more readily accepted by respiratory physicians and published findings appeared to support its clinical utility.[8-10,18,27] A diagnostic yield of more than 90% had been reported with semi-rigid instruments used to investigate patients with undiagnosed pleural effusions,[10,18] which is comparable to the 80 to 96% average yield with its rigid counterparts.[4,20-23,28-30] Although our initial diagnostic yield of 79% would appear to be slightly lower, accumulation of experience and careful case selection was likely to improve future results.[4,24] In our series, the presence of extensive adhesions in one of our cases led to incomplete collapse of the lung, which limited examination of the pleural space, and prevented an appropriate biopsy. Preoperative CT and USG thorax can detect septations or loculation and hence predict extensive adhesions, which are considered to be absolute contra-indications for pleuroscopy.[2] Partial removal of pleural fluid or induction of a pneumothorax under fluoroscopic control[24] might also be a useful means of ascertaining the presence of adequate air space before trocar insertion.

Our study showed that the procedure was well tolerated, had a low pain score, and required only a low dose of midazolam. Previous reports also indicate that major complications or procedure-related mortality was rare.[4] The most common and severe complication following medical thoracoscopy was massive bleeding.[4] However, this risk is low with the semi-rigid pleuroscope, due to the smaller size of biopsy forceps, and can be prevented by taking biopsies from the pleura overlying the ribs (to avoid damaging intercostal vessels). Self-limiting post-procedural fever in two of our patients was very likely due to the effect of talc.[30] In two others, there was a degree of mild, localised subcutaneous emphysema around the trocar site. 'Trapped lung' as a result of carcinoma of bronchus accounted for the persistent space inside the pleural cavity that did not resolve despite prolonged chest drainage. Our results were similar to those reported in the literature,[8-10,18,27] whereby complications related to the use of the semi-rigid thoracoscope were rare and there was virtually no mortality.

However, the semi-rigid instrument is not without its limitations and in certain situations might not perform as well as the rigid scope.[2] The biopsies taken with the semi-rigid instrument are smaller, being limited by the size of the working channel and the size of the forceps.[9] Rigid instruments might also be more appropriate in patients with pleuro-pulmonary adhesions, loculated pleural effusions, empyema and pneumothorax with bullae or blebs.[2] Furthermore, the trocar is rather short (working length, 60 mm) and might not be ideal for patients with obesity or thick intercostal muscles. The rigid instrument with two ports of entry would also be more effective for the control of bleeding, although semi-rigid thoracoscopes are also equipped with electrocautery accessories.

Since talc was found to be superior to other agents for pleurodesis,[30] its insufflation or slurry has been commonly utilised to prevent recurrence of malignant pleural effusions. The efficacy of talc pleurodesis had been described to be up to 90%, whether applied via insufflation or slurry.[31-34] However, talc powder insufflated over the inner surface of hemithorax might theoretically provide a more even distribution, while talc slurry tends to accumulate in dependent areas leading to incomplete pleural symphysis.[11] Although there had been concerns about its safety,[35] the use

of a larger particle size talc for pleurodesis has been associated with a lower rate of complications such as adult respiratory distress syndrome.[36,37] Whilst the number of patients in our study was small, pleurodesis by talc insufflation via pleuroscopy, utilising talc with larger particle size, was shown to be safe and reasonably efficacious. Conceivably, availability of frozen section examinations of pleural biopsies during pleuroscopy might enable the endoscopist to decide on whether to proceed to pleurodesis in the same thoracoscopic setting.[38]

Although this was a prospective study with systematic collection of data in consecutive patients undergoing pleuroscopy, it was limited by its small size and hence no comparisons were made with patients having conventional closed pleural biopsies or thoracoscopy via the VATS approach. Also, the efficacy of the procedure might be underestimated, since we only report our initial experience (during the 'learning curve') from a single centre. Sensitivity and specificity levels of the procedure have not been evaluated, because VATS was not carried out in the cases where the diagnosis was not certain. For the two cases where the diagnosis was not established after thoracoscopy and whose effusions did not recur, apart from treated bacterial parapneumonic effusions, or TB pleural effusions that resolved spontaneously, 'idiopathic benign pleuritis' was another rare possibility.[39]

Conclusion

Pleuroscopy using a semi-rigid thoracoscope has emerged as a valuable tool for respiratory physicians to evaluate pleural effusions of unknown aetiology, after pleural tapping and biopsy. It can also be used for therapeutic purpose such as talc pleurodesis to treat malignant pleural effusions. This is a very safe and well-tolerated procedure with a high diagnostic yield for pleural diseases. Careful case selection and accumulation of experience will improve the diagnostic and therapeutic utility of the procedure.

References

1. Prakash UB, Reiman HM. Comparison of needle biopsy with cytologic analysis for the evaluation of pleural effusions: analysis of 414 cases. Mayo Clin Proc 1985;60:158-64.
2. Lee P, Colt HG. Rigid and semirigid pleuroscopy: the future is bright. Respirology 2005;10:418-25.
3. Lee P, Colt HG. Flex-rigid pleuroscopy: step by step. Singapore: CMP Medica Asia; 2005.
4. Loddenkemper R. Thoracoscopy—state of the art. Eur Respir J 1998;11:213-21.
5. Hansen M, Faurschou P, Clementsen P. Medical thoracoscopy, results and complications in 146 patients: a retrospective study. Respir Med 1998;92:228-32.
6. Ferrer J, Roldán J, Teixidor J, Pallisa E, Gich I, Morell F. Predictors of pleural malignancy in patients with pleural effusion undergoing thoracoscopy. Chest 2005;127:1017-22.
7. Colt HG. Thoracoscopy. A prospective study of safety and outcome. Chest 1995;108:324-9.
8. Ernst A, Hersh CP, Herth F, et al. A novel instrument for the evaluation of the pleural space: an experience in 34 patients. Chest 2002;122:1530-4.
9. McLean AN, Bicknell SR, McAlpine LG, Peacock AJ. Investigation of pleural effusion: an evaluation of the new Olympus LTF semiflexible thoracofiberscope and comparison with Abram's needle biopsy. Chest 1998;114:150-3.
10. Lee P, Hsu A, Lo C, Colt HG. Prospective evaluation of flex-rigid pleuroscopy for indeterminate pleural effusion: accuracy, safety and outcome. Respirology 2007;12:881-6.
11. American Thoracic Society. Management of malignant pleural effusions. Am J Respir Crit Care Med 2000;162:1987-2001.
12. Cantó A, Ferrer G, Ramagosa V, Moya J, Bernat R. Lung cancer and pleural effusion. Clinical significance and study of pleural metastatic locations. Chest 1985;87:649-52.
13. Tomlinson JR, Sahn SA. Invasive procedures in the diagnosis of pleural disease. Semin Respir Crit Care Med 1987;9:31-6.
14. Starr RL, Sherman ME. The value of multiple preparations in the diagnosis of malignant pleural effusions. A cost-effective analysis. Acta Cytol 1991;35:533-7.
15. Jacobaeus HC. Ueber die Moglichkeit die zystocopie bei Untersuchung serosen Hohlungen anzuwenden. Munch Med Wochenschr 1910;57:2090-2.
16. Tape TG, Blank LL, Wigton RS. Procedural skills of practicing pulmonologists. A national survey of 1,000 members of the American College of Physicians. Am J Respir Crit Care Med 1995;151:282-7.
17. Munavvar M, Shakur R, Corless M, Singh H, Guirguis A. Survey of the practice of interventional bronchoscopy in UK [abstract]. Thorax 2004; 59(Suppl II):76S.
18. Munavvar M, Khan MA, Edwards J, Waqaruddin Z, Mills J. The autoclavable semirigid thoracoscope: the way forward in pleural disease? Eur Respir J 2007;29:571-4.
19. Maskell NA, Butland RJ; Pleural Diseases Group, Standards of Care Committee, British Thoracic Society. BTS guidelines for the investigation of a unilateral pleural effusion in adults. Thorax 2003;58(Suppl 2):ii8-17.
20. Boutin C, Viallat JR, Cargnino P, Farisse P. Thoracoscopy in malignant pleural effusions. Am Rev Respir Dis 1981;124:588-92.
21. Cantó A, Blasco E, Casillas M, et al. Thoracoscopy in the diagnosis of pleural effusion. Thorax 1977;32:550-4.
22. Menzies R, Charbonneau M. Thoracoscopy for the diagnosis of pleural disease. Ann Intern Med 1991;114:271-6.
23. Blanc FX, Atassi K, Bignon J, Housset B. Diagnostic value of medical thoracoscopy in pleural disease: a 6-year retrospective study. Chest 2002;121:1677-83.
24. Boutin C, Viallat JR, Aelony Y. Thoracoscopy technique. In: Practical thoracoscopy. Berlin: Springer-Verlag; 1992:13-41.
25. Davidson AC, George RJ, Sheldon CD, Sinha G, Corrin B, Geddes DM. Thoracoscopy: assessment of a physician

service and comparison of a flexible bronchoscope used as a thoracoscope with a rigid thoracoscope. Thorax 1988;43:327-32.
26. Edmondstone WM. Investigation of pleural effusion: comparison between fibreoptic thoracoscopy, needle biopsy and cytology. Respir Med 1990;84:23-6.
27. Sakuraba M, Masuda K, Hebisawa A, Sagara Y, Komatsu H. Diagnostic value of thoracoscopic pleural biopsy for pleurisy under local anaesthesia. ANZ J Surg 2006;76:722-4.
28. Loddenkemper R, Mai J, Scheffler N, Brandt HJ. Prospective individual comparison of blind needle biopsy and of thoracoscopy in the diagnosis and differential diagnosis of tuberculous pleurisy. Scand J Respir Dis Suppl 1978;102:196-8.
29. Mårtensson G, Pettersson K, Thiringer G. Differentiation between malignant and non-malignant pleural effusion. Eur J Respir Dis 1985;67:326-34.
30. Walker-Renard PB, Vaughan LM, Sahn SA. Chemical pleurodesis for malignant pleural effusions. Ann Intern Med 1994;120:56-64.
31. Hartman DL, Gaither JM, Kesler KA, Mylet DM, Brown JW, Mathur PN. Comparison of insufflated talc under thoracoscopic guidance with standard tetracycline and bleomycin pleurodesis for control of malignant pleural effusions. J Thorac Cardiovasc Surg 1993;105:743-8.
32. Rodriguez Panadero F. Lung cancer and ipsilateral pleural effusion. Ann Oncol 1995;6(Suppl 3):25S-27S.
33. Marom EM, Patz EF Jr, Erasmus JJ, McAdams HP, Goodman PC, Herndon JE. Malignant pleural effusions: treatment with small-bore-catheter thoracostomy and talc pleurodesis. Radiology 1999;210:277-81.
34. Jacobi CA, Wenger FA, Schmitz-Rixen T, Müller JM. Talc pleurodesis in recurrent pleural effusions. Langenbecks Arch Surg 1998;383:156-9.
35. Light RW. Talc should not be used for pleurodesis. Am J Respir Crit Care Med 2000;162:2024-6.
36. Maskell NA, Lee YC, Gleeson FV, Hedley EL, Pengelly G, Davies RJ. Randomized trials describing lung inflammation after pleurodesis with talc of varying particle size. Am J Respir Crit Care Med 2004;170:377-82.
37. Janssen JP, Collier G, Astoul P, et al. Safety of pleurodesis with talc poudrage in malignant pleural effusion: a prospective cohort study. Lancet 2007;369:1535-9.
38. Fielding D, Hopkins P, Serisier D. Frozen section of pleural biopsies at medical thoracoscopy assists in correctly identifying benign disease. Respirology 2005;10:636-42.
39. Venekamp LN, Velkeniers B, Noppen M. Does 'idiopathic pleuritis' exist? Natural history of non-specific pleuritis diagnosis after thoracoscopy. Respiration 2005;72:74-8.