Medical Thoracoscopy/ Pleuroscopy: Manual and Atlas

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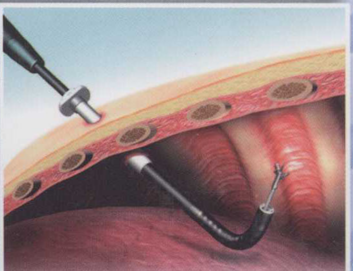
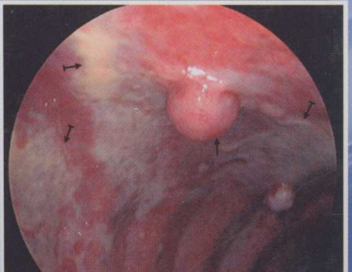
DVD included

Foreword by John F. Murray





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Medical Thoracoscopy/Pleuroscopy: Manual and Atlas

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Foreword

The fact that my medical career started back in the first half of the last century means, of course, that I must be very old, which I am–well past 80–but it also means that for over 60 years I have been both witness to and participant in the spectacular advances that have revolutionized the understanding and practice of medicine in general and of pulmonary medicine in particular. Certainly, this experience provides an advantageous perspective from which to write a foreword to this edition of *Medical Thoracoscopy/ Pleuroscopy: Manual and Atlas*, a thoroughly revised and updated book about a resurgent procedure that is both underappreciated and underutilized in many countries, including the United States, and that is gaining importance in the diagnosis and treatment of a variety of pleuropulmonary diseases.

In the 1950s, at the beginning of my career as a pulmonologist, I cared for many patients with tuberculosis, the signature disease of the specialty. But during the ensuing decade, tuberculosis began to decrease in incidence and became mostly a curable instead of a chronic and often fatal condition; in addition, the focus of its care shifted from the hospital (or sanatorium) to the clinic (or office). Pulmonary physicians, however, became even busier than before as their responsibilities shifted from patients with tuberculosis to those with diseases that were by no means new but which we began to see in increasing numbers–asthma, chronic obstructive pulmonary disease, and cancer of the lung: a trend that to a large extent continues today.

By the mid-1960s, I took advantage of the steadily diminishing number of patients with tuberculosis that required hospitalization in my 158-bed "TB Building" at San Francisco General Hospital by converting one of the newly emptied wards into an intensive care unit for patients with respiratory disease. The burgeoning number of intensive care units at the time provided a welcome home to physicians trained in pulmonary medicine, not only because of the frequency with which serious lung conditions —such as community-acquired pneumonia, status asthmaticus, and exacerbations of COPD—were the cause of admission, but because of the recurring need for mechanically assisted ventilation in desperately ill patients. Pulmonary specialists were well-versed in respiratory physiology, including the mechanics of breathing, which was a subject of much research and academic activity, and which coincided with considerable corporate interest in the development and marketing of ventilators. Soon, my dedicated "respiratory" facility became a full-fledged "medical" intensive care unit, and I became more and more involved in critical care, becoming an expert in a subspecialty that did not even exist when I was certified in pulmonary medicine.

Today's clinicians—skilled in contemporary medical practices and in the use of life-saving pharmacology and technology—take for granted what older physicians appreciate and still marvel at. And this is true not just in the practice of intensive care or pulmonology, but in each one of the many branches of medicine. Everyone agrees: remarkable discoveries have improved the lives of both patients and their doctors. Consider only one example: the spectacular advances that have occurred in diagnostic methodology. Currently, not many diseases escape definitive diagnosis by available microbiological, biochemical, and pathological analyses of specimens obtained from all the usual sources and, when needed, from hard-to-reach, formerly inaccessible sites. Moreover, application of highly advanced diagnostic methods quickly identified previously unknown and important clinical scourges, such as Legionnaire's disease, hantavirus pulmonary infection, human immunodeficiency virus infection and its partner in death and disability the acquired immunodeficiency syndrome, mad cow disease, and, more recently, severe acute respiratory syndrome (SARS): all of which have come to light during my professional lifetime.

Modern practitioners are blessed with imaging techniques of exceptional clarity and precision, which have replaced older sometimes dangerous and always unpleasant diagnostic methods: my father nearly died from an air encephalogram; today he would have been easily diagnosed by magnetic resonance imaging. Not many practicing pulmonary specialists realize how difficult bronchography was for doctors to perform and for patients to endure; now, when we need to map the extent and severity of bronchiectasis, we simply write an order for high-resolution computed tomography of the lungs. All of us welcomed ultrasonography into our diagnostic armamentarium, a convenient and noninvasive way of looking—for the first time—deep inside the heart, blood vessels, abdomen, and pelvis to identify anatomical and functional abnormalities, including the presence and location of pleural fluid in the chest.

Within the last decade or so, we have witnessed the flourishing of a breed of subspecialists called interventionists, descendents of a group of intrepid pioneers who, as the authors of this *Manual and Atlas* tell us, started probing body cavities around a century ago. Now, however, endowed with ultra-modern high-tech instruments, interventionists not only examine the insides of various cavities and organs, but they are able to do something about the abnormalities they find there. Surgeons are, without doubt, the consummate interventionists, but the practice has broadened to other chiefly "medical" specialists. Currently, we have interventional radiologists, interventional cardiologists, and interventional gastroenterologists. Plus, there is a scattering of interventional pulmonologists but, as the authors of this *Manual and Atlas*, who come from Europe, North America, and Asia, persuasively state, there should be many more. After proper training and experience in medical thoracoscopy or pleuroscopy (interchangeable terms), pulmonary specialists have much to offer in the diagnosis and management of patients with lung disease, especially those with pleural effusions, but including those with pneumothorax, empyema, and other conditions as well.

A brief review of my 60-plus years of repeated frustrations trying to diagnose and manage patients who presented with pleural effusions of uncertain etiology underscores the valuable additions to pulmonary medicine now provided by medical thoracoscopy. Traditionally, in teaching hospitals, thoracenteses are performed by interns and residents, and I did my share, although I don't remember doing very many. I also carried out a few artificial pneumothoraces, including one induction, for collapse therapy of pulmonary tuberculosis, although pneumoperitoneum was the preferred treatment in both hospitals I trained in.

Back then, the fluid we aspirated was not of much diagnostic value; measurements of the numbers and types of white blood cells and the protein concentration seldom altered clinical thinking, and cultures were only occasionally positive. The availability of cytology helped considerably, and we were even more delighted when, practically simultaneously, the Cope and Abrams needles appeared: here at last was a chance of making a definitive diagnosis. But not always. The report of one of my first biopsies, which provoked a brisk hemorrhage, showed a "fragment of arterial wall." Later, we profited from the diagnostic orientation afforded by Light's criteria, greatly improved culture methods, including for anaerobic organisms, and the development of biochemical tests such as N-terminal pro-brain natriuretic peptide (NT-BNP), adenosine deaminase, and gamma-interferon.

Obviously, all these additions and refinements helped. Although it is hard to generalize because of differences in technical approaches and in clinical settings, the yield from analysis and culture of thoracentesis fluid plus histological examination and culture of specimens obtained by closed pleural biopsy establish a diagnosis of tuberculous pleurisy with effusion in 70–80% of cases. (Even though finding a high level of adenosine deaminase or gamma-interferon in blood or discovering caseating granulomas in pleural tissue provides a satisfactory working diagnosis, it remains important—and increasingly so—in some settings to culture *Mycobacterium tuberculosis* and to identify drug-resistant strains.) Image-guided pleural biopsy undoubtedly raises the diagnostic yield above 80% in patients with tuberculous pleural effusion, but it is close to 100% with thoracoscopy and the result of culture of thoracoscopic specimens is higher than from any other source. Sadly, these more sensitive procedures are seldom available where they are needed most: in resource-poor countries where the incidence of tuberculosis is extremely high.

Studies in patients who turn out to have malignant pleural effusions typically show a low diagnostic return from closed pleural biopsy when pleural fluid cytology is negative. Here again, the yield is increased by image-guided pleural biopsy, but raised even higher by thoracoscopy, which is clearly the best way of diagnosing pleural malignancies when suspicion is high and simpler approaches are unrevealing; thoracoscopy also furnishes the opportunity for performing talc poudrage under direct vision for optimum pleurodesis: when the procedure is indicated.

So for more than half a century, the work-up of patients with pleural effusion of unknown etiology has steadily improved, always in the direction of more reliable and safer ways of making an accurate diagnosis, thus paving the way for effective treatment. The point is that diagnostic algorithms are constantly evolving and that they now include medical thoracoscopy.

The appearance of this *Manual and Atlas* is timely, and the book fills a pressing need: it details the latest methodology; it offers numerous photographs of the various abnormalities that may be encountered during medical thoracoscopy; and it discusses controversial issues regarding indications and provides evidence-based recommendations for when the procedure should be carried out. And there is more. As stated earlier, medical thoracoscopy has been used and is being tried in patients with conditions other than pleural effusion, and the book deals with what these conditions are and how the procedure may help. Here at last is an excellent way for pulmonary specialists to start taking advantage of the diagnostic and therapeutic benefits of medical thoracoscopy.

John F. Murray, MD, FRCP
Professor Emeritus of Medicine
University of California, San Francisco

Preface

Exactly a hundred years ago, Hans-Christian Jacobaeus published his pioneering article on the use of the cystoscope for examination of serous cavities, which he called thoracoscopy and laparoscopy. Although he developed thoracoscopy primarily as a diagnostic method in pleural effusions, he soon used and propagated it for lysis of pleural adhesions, by means of thoracocautery, to accomplish an artificial pneumothorax. The technique became very popular in the preantibiotic era for collapse treatment of pulmonary tuberculosis.

Around 1950, with the advent of antibiotic treatment for tuberculosis, the era of pneumothorax therapy came to an end and other diseases became increasingly important to the chest physician. Consequently, a generation of physicians already familiar with therapeutic application of thoracoscopy, mainly in Europe, began to use this technique on a much broader basis for evaluation of many pleuropulmonary diseases. The *Atlas of Diagnostic Thoracoscopy*, published in 1985, summarized these experiences.

However, during the last 25 years, many new developments have had an enormous impact on the application of thoracoscopy. Imaging techniques such as CT and MRI very often deliver the diagnosis in localized chest lesions. Transbronchial lung biopsies and bronchoalveolar lavage (BAL) in combination with HRCT frequently allow the differentiation of diffuse lung diseases. In the early 1990s, tremendous advances in endoscopic technologies stimulated the development from thoracoscopy to minimally invasive thoracic surgery/video-assisted thoracic surgery (VATS). For better distinction from "surgical thoracoscopy," the term "medical thoracoscopy" was introduced. With the introduction of the semirigid (semiflexible) pleuroscope, the term "pleuroscopy" became popular. Talc poudrage, performed during thoracoscopy, has now become widely accepted as the preferred method for pleurodesis, and medical thoracoscopy/pleuroscopy (MT/P) is meanwhile considered to be one of the main areas of interventional pulmonology.

All these changes during the last 25 years gave us reason to edit this new *Manual and Atlas*, which describes in detail the different technical approaches as well as today's diagnostic and therapeutic indications. We hope that this update on the various techniques, described by editors from Europe, North America, and Asia, together with the endoscopic photographs and the accompanying DVD with videos of typical cases, will further promote the use of this easy-to-learn technique.

We thank Olympus Europa Holding GmbH for support in the production of this book and the permission to use the procedural video of medical thoracoscopy under local anesthesia. We would also like to thank Angelika Findgott, Anne Lampater, Elisabeth Kurz, and Clifford Bergman for careful handling and aid in editing the book.

We are especially grateful to John F. Murray, Professor Emeritus of Medicine, University of California, San Francisco, and one of today's most preeminent pulmonologists, for his foreword in which he puts the method into the context of the whole field of respiratory medicine.

Robert Loddenkemper
Praveen Mathur
Marc Noppen
Pyng Lee

Abbreviations

A–a gradient	alveolar–arterial gradient
ACCP	American College of Chest Physicians
ACGME	Accreditation Council for Graduate Medical Education
ADA	adenosine deaminase
ARDS	acute respiratory distress syndrome
BAPE	benign asbestos pleural effusion
CEA	carcinoembryogenic antigen
cm H_2O	centimeters of water [pressure] 1 cm H_2O = 98.0665 pascals (Pa) = 0.980 665 millibar (mbar) ≈ 1 mbar
CME	Continuing Medical Education
COPD	chronic obstructive pulmonary disease
ECG	electrocardiography
HRCT	high-resolution computed tomography
IPF	idiopathic pulmonary fibrosis
IGRAs	interferon-gamma release assays
INR	International Normalized Ratio
LVRS	lung volume reduction surgery
MDR	multidrug resistance
MT/P	medical thoracoscopy/pleuroscopy
NBI	narrow band imaging
NETT	National Emphysema Treatment Trial
PET	positron emission tomography
PPE	parapneumonic effusions
PSP	primary spontaneous pneumothorax
RBILD	respiratory bronchiolitis associated interstitial lung disease
SSP	secondary spontaneous pneumothorax
TB	tuberculosis
TLB	thoracoscopic lung biopsy
UIP	usual interstitial pneumonia
VATS	video-assisted thoracic surgery
WLT	white-light thoracoscopy
XDR	extensive drug resistance

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Section A: Manual

1 Introduction

The Role of Medical Thoracoscopy/ Pleuroscopy in Respiratory Medicine

Endoscopic procedures play an essential role in the diagnostic evaluation of patients with respiratory diseases. These techniques were mainly developed and refined during the last century. The recent tremendous advances in endoscopic technology with sophisticated instruments and telescopes with extremely high optimal resolution and small diameters, as well as developments in anesthesiology, offer a wide range of diagnostic and therapeutic possibilities.

Thoracoscopy, introduced 100 years ago, is—after bronchoscopy—the second most important endoscopic technique in respiratory medicine. In the past, the vast majority of respiratory specialists (pulmonologists/pneumologists/chest physicians) performed only flexible bronchoscopy, thoracentesis, and chest tube placement. A growing number now perform medical thoracoscopy/ pleuroscopy as well. Just as the art and science of flexible bronchoscopy has evolved since its introduction in the 1960s, medical thoracoscopy/pleuroscopy (MT/P) will follow as more pulmonologists, already adept and comfortable with flexible endoscopic instruments, venture to explore the pleural space with the semirigid (semiflexible) pleuroscope ("Thoracoscopy: window to the pleural space" [Colt 1999], "Pleuroscopy: a window to the pleura" [Mathur 2004]. MT/P is meanwhile considered to be one of the main areas of interventional pulmonology (Beamis and Mathur 1999; Seijo and Sterman 2001; Beamis et al. 2004; Lee et al. 2010).

The definition of interventional pulmonology is the art and science of medicine related to the performance of invasive diagnostic and therapeutic procedures that require additional training and expertise beyond that required within a standard training program in respiratory medicine (Beamis and Mathur 1999).

In many European countries medical thoracoscopy has already been part of the training program in respiratory medicine for many years (Dijkman et al. 1994; UEMS 1995; Loddenkemper et al. 2006; Loddenkemper et al. 2008). It has also become more popular in the United States, where according to the national survey in 1994, medical thoracoscopy was applied frequently by 5% of all pulmonary physicians (Tape et al. 1995). Although newer data are not available, the interest in the technique seems to be increasing (Lee et al. 2003; Loddenkemper 2003). However, training is lagging; in an American College of Chest Physicians (ACCP) survey of US pulmonary/critical care fellowship programs in 2002/2003, only 12% of the directors stated that MT/P was offered in their programs (Pastis et al. 2005). In the United Kingdom, where medical thoracoscopy was underutilized compared with the rest of Europe, there is also growing interest (Burrows et al. 2006; Medford et al. 2010). Meanwhile, the technique has been introduced successfully in Australia as well as in many Asian, South American, and some African countries.

MT/P is an invasive technique that should be used to obtain a diagnosis only when other, simpler methods are nondiagnostic (mainly in case of pleural exudates). But, in addition to its several diagnostic advantages, it offers certain therapeutic possibilities, in particular talc poudrage, to achieve pleurodesis (in case of recurrent pleural effusion or pneumothorax) (Loddenkemper 1998; Tassi et al. 2006; Rodriguez-Panadero 2008).

As with all technical procedures requiring special skills, there is a learning curve before full competence is achieved (Boutin et al. 1981a; Rodriguez-Panadero 1995). Appropriate learning is therefore mandatory (Loddenkemper 1998; Ernst et al. 2003). The technique is actually very similar to chest tube insertion by means of a trocar, the difference being that the thoracoscope/pleuroscope is introduced before the insertion of the chest tube. Thus, the whole pleural cavity can be visualized, and biopsies can be taken from all areas of the pleural cavity, including the chest wall, diaphragm, lung, and even mediastinum (Loddenkemper 1998). In general, medical thoracoscopy/pleuroscopy is easier to learn than flexible bronchoscopy if sufficient expertise in thoracentesis and chest tube placement has already been gained. When indicated, talc poudrage can be performed prior to chest tube insertion, allowing a very homogeneous distribution of talc on the visceral and parietal pleural surface. Today, this is the gold standard for nonsurgical pleurodesis (Rodriguez-Panadero and Antony 1997; Antony et al. 2000).

Although medical thoracoscopy/pleuroscopy are invasive techniques, it is necessary to outline important differences in comparison with surgical thoracoscopy or video-assisted thoracic surgery, which are much more invasive and expensive, usually requiring selective double-lumen intubation under general anesthesia, multiple points of entry, disposable instruments, and an operating theater (Kaiser and Daniel 1993). Because the term is now used for both the medical and the surgical procedures, a degree of uncertainty has arisen, which may lead to unnecessary surgical interventions for what are in fact medical indications.

Thus, to distinguish it better from the surgical approach, the term "medical thoracoscopy" was introduced (Mathur et al. 1994). This method is actually performed under local anesthesia or conscious sedation, via only one or two points of entry, by the respiratory physician in an endoscopy suite, using nondisposable instruments. To further clarify the difference from the surgical procedure, and to avoid confusion in the future, it has been suggested that the old term "pleuroscopy," as used in the early French literature (Piguet and Giraud 1923), and as proposed by Weissberg (1991) for the sake of clarity, should be favored over "medical thoracoscopy." Today, both terms are used in parallel, but often the term "medical thoracoscopy" is preferred for the technique using rigid instruments, and the term "pleuroscopy" for the technique using semirigid (semiflexible) instruments. Another alternative has been proposed in the United Kingdom, with the term "thoracoscopy for physicians" (Buchanan and Neville 2004).

The added term "video-assisted" can be confusing, since this is very often associated with video-assisted thoracic surgery (VATS). However, here it actually means only that direct inspection through the thoracoscope is not used, but rather the inspection is performed indirectly by video-assisted observation, which can be employed both with the semirigid (semiflexible) pleuroscope and with the rigid thoracoscope for medical thoracoscopy.

The recent development of medical and surgical thoracoscopy coincided with several technical improvements, as well as with a renewed interest in this field of respiratory medicine. This is underlined by the enormous increase in literature. In PubMed, under the terms "thoracoscopy," "pleuroscopy," "thoracoscopy and pleuroscopy," and "VATS," enormous numbers of publications (more than 8300) are cited today, demonstrating on the one hand the lack of distinction between the medical and surgical approach, and on the other hand the great interest in the technique, which has grown exponentially since the first edition of the *Atlas of Diagnostic Thoracoscopy* was published in 1985. Until 1982, the total world literature consisted of only approximately 240 publications relating to the clinical applications of thoracoscopy in pleuropulmonary diagnosis (Brandt et al. 1985; Loddenkemper 2004a).

In conclusion, medical thoracoscopy/pleuroscopy, in our experience, is easier to learn than flexible bronchoscopy, provided that sufficient skills in thoracentesis and chest tube placement have already been acquired and the appropriate mandatory training has been accomplished.

This book aims to lay the basis for learning and teaching the technique with its *Manual* part, explaining in depth the techniques, indications, results, contraindications, complications, etc., together with the *Atlas* part, showing in color endoscopic examples of different pathologies.

The associated DVD demonstrates the diagnostic and therapeutic techniques of medical thoracoscopy/pleuroscopy, together with some typical case presentations.

History and Development of Thoracoscopy/Pleuroscopy

Thoracoscopy is based on the development of the artificial pneumothorax, of endoscopes, and of pleural drainage. It was the combination of these three essentials that led to the introduction of the technique in 1910 by Hans-Christian Jacobaeus (**Fig. 1.1a, b**), who worked as an internist in Stockholm, Sweden (Jacobaeus 1910).

Artificial Pneumothorax

The first publication describing artificial pneumothorax can be found in the Hippocratic writings. In Chapter 59 of the second book of diseases "Adhesion of the lung to the pleura," it is stated: "If this disease (pleuritis) is caused by injury or is present in a patient with empyema as a result of a penetrating wound, one should attach an air-filled bladder to a tube and insert it. One should then take a strong instrument of tin and push. With such therapy, one should have the most luck" (Hippocrates, cited in Kapferer and Sticker 1933). Introducing air seems to indicate the establishment of pneumothorax, the little tube suggests drainage, and the tin instrument perforation of the chest wall (although the sequence is not quite clear). The bladder might have been used to catch pus or exudate in a closed system after establishing the pneumothorax.

It was only in 1821 that the Scottish physiologist Carson presented the concept of an artificial pneumothorax to the Liverpool Medical Society (Carson, cited in Schmidt 1938). Based on his experiences in rabbits, Carson seems to have been the first to conceive the idea of minimizing lung scarring in tuberculosis by producing a pneumothorax in humans. Later, in 1882, Forlanini in Italy proposed a closed pneumothorax induced by means of fine, sterile needles (Forlanini 1882). He used this method for the first time in a human in 1888 in the presence of a pleural exudate, and in 1894 he produced a pneumothorax in a previously normal pleural space. For the latter, he used nitrogen because of its very slow reabsorption since he wanted to produce a prolonged therapeutic collapse of the affected lung in patients with pulmonary tuberculosis. Saugmann introduced the water manometer for the purpose of producing a controlled pneumothorax in 1902 (Saugmann 1902, cited in Schmidt 1938; Faurschou and Viskum 1997). All of these pneumothorax experiments were performed for therapeutic purposes.

Fig. 1.1 Hans-Christian Jacobaeus (1879–1937). **a** In 1903 (courtesy of Gianpietro Marchetti). **b** In the 1930s.

Pleural Drainage

The development of pleural suction drainage for the purpose of reexpanding the lung is closely connected to closed drainage of empyemas and to the therapy for pneumothorax. Some of this was even alluded to in the Hippocratic writings. It was probably Hewitt who, in the modern era, first developed the underwater seal for pleural drainage (Hewitt 1876, cited in Enerson and McIntyre 1966) and who, in 1876, provided instructions at the London Hospital concerning "the value of the pneumatic aspirator." The management of pleural empyema was the subject of a medical congress in Vienna in 1891, and in the same year Bülau wrote his famous article "On suction drainage in the treatment of empyema" (Bülau 1891). The large number of empyemas during the influenza epidemic in 1918 led to the recommendations of the Empyema Commission in Virginia (Empyema Commission 1918, cited in Enerson and McIntyre 1966).

According to Sattler, in 1940 "there were many opinions regarding the most useful and correct measures for the treatment of pneumothorax which were confusing, lacked uniformity or were completely contradictory" (Sattler 1940). Careful thoracoscopic evaluations and studies of pleurodesis, using continuous suction, together with the development of drainage procedures following lung resection, have resulted in the current, highly developed technique of continuous closed pleural suction drainage (Roe 1958; Munnell 1997).

Introduction of Thoracoscopy as a Diagnostic Method

Hans-Christian Jacobaeus (1879–1937) primarily developed thoracoscopy as a diagnostic method. In 1910, he described the technique at the same time as laparoscopy in a paper entitled "On the possibility to use cystoscopy in the examination of serous cavities" (Jacobaeus 1910). At that time, as a result of the development of suitable optical systems in the nineteenth century, endoscopy was already being applied to all organs and hollow cavities with anatomical connections to the exterior (Moisiuc and Colt 2007).

Recently, it has been reported that Francis-Richard Cruise, born in Dublin/Ireland in 1834, was probably the first to perform thoracoscopy as early as 1866. This was brought to light in an article entitled "Thoracoscopy before Jacobaeus" (Hoksch et al. 2002). The authors also point out that the term "thoracoscopy" was well known in several French dictionaries before Jacobaeus defined it, as "exploration of the thoracic cavity" (Larousse 1878, cit-


Aus dem westlichen Krankenhause der Allgemeinen Fürsorge-anstalt in Stockholm (Oberarzt: Dr. G. Wilkens).

Ueber die Möglichkeit die Zystoskopie bei Untersuchung seröser Höhlungen anzuwenden.

Vorläufige Mitteilung.

Von H. C. Jacobaeus, Privatdozent in Stockholm.

Die mit der äusseren Körperfläche durch natürliche Oeffnungen in Verbindung stehenden Hohlräume des Organismus, war man seit langem instand gesetzt, mit verschiedenen Licht- und Spiegelanordnungen zu beleuchten und infolgedessen auch mit dem Auge zu untersuchen.

Muenchener Medizinische Wochenschrift

57: 2090 - 2092 (1910)

Fig. 1.2 Title page of the 1910 publication of Jacobaeus.

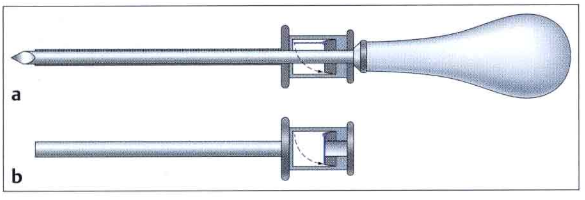

Fig. 1.3 Original trocar (**a**) and automatically closing valve (**b**) from Jacobaeus (1910).

ed by Hoksch et al. 2002). Cruise, who in 1865 had already published on an "Endoscope as an aid to the diagnosis and treatment of disease" (Cruise 1865), performed an "Examination of interior of pleura by endoscope" in an 11-year-old girl with empyema through a pleurocutaneous fistula that had developed after pleural drainage, and he used the technique for monitoring therapy. This was reported by Samuel Gordon, who cared for this patient for about 9 months but, because of a deteriorating course, asked Cruise to help him by using his endoscopic skills (Gordon 1866). Although it was published in the *Dublin Quarterly Journal of Medical Science*, the technique remained anecdotal.

Jacobaeus, in his pioneer paper (published in German in the *Münchener Medizinische Wochenschrift*, one of the leading journals at that time) (**Fig. 1.2**), mentioned two cases of tuberculous pleural effusion (pleuritis exsudativa) in which he studied the pleural surfaces after replacing fluid with air according to Holmgren's technique. Although not initially able to safely characterize the pleural changes, he expressed his confidence that the method would be successful with more training, and that it might even eventually yield prognostic information. Jacobaeus closed his publication by mentioning that he had no experience using the cystoscope in the pericardium, but that he believed that this might also eventually be possible (Jacobaeus 1910).

Jacobaeus began his "Preliminary Communication" by referring to endoscopy of organs with natural openings, such as the urinary tract, and referred to the work of Max Nitze, who, in 1877, developed the first cystoscope with a telescopic lens and distal illumination (Nitze 1879). Jacobaeus then commented that closed cavities such as the peritoneum, pleura, and pericardium had not been examined endoscopically. For this kind of "cystoscopy," Jacobaeus defined three main prerequisites:

1. The possibility to introduce a trocar (or puncture needle) into the relevant cavity without lacerating the inner organs and without causing too much pain.
2. The introduction of a transparent medium into the cavity—Jacobaeus used filtered air for this purpose.
3. A cystoscope of such small dimensions that it could be introduced through the trocar.

Figure 1.3a, b shows the trocar Jacobaeus used, which contained an automatically closing valve. It was built with the assistance of Dr. A. Ahlström, chief instrument maker at Stille-Werner in Stockholm. The whole apparatus had a diameter of only 17 Charrière (1 Charrière = 0.33 mm), with the cystoscope having a diameter of 14 Charrière.

Jacobaeus delineated the basic procedure as follows: The skin was disinfected and anesthetized with cocaine. Following a small skin incision, the trocar was introduced with or without prior insufflation of air into the cavity. Once the trocar was introduced, filtered air was insufflated by means of a simple Politzer air pump. The cystoscope was then introduced through the trocar, and the inspection was performed. Jacobaeus then described in detail how the peritoneum was examined. He called this "laparoscopy," and he initially practiced it in over 50 cadavers before successfully performing the procedure in three patients.

In the second, much smaller part of his discussion, Jacobaeus described in detail the examination of pleural cavities, which he called "thoracoscopy." He stated that in this procedure the three above-mentioned main prerequisites are fulfilled more closely than in laparoscopy, especially with regard to point (1) (introduction of the trocar), which he considered to be much less dangerous in the thorax. He referred to a technique developed by Dr. Israel Holmgren, who substituted the fluid with air ("exhalation of the exudate"). He also cited Forlanini's method, in which air or nitrogen was blown into the pleural space, and which under certain circumstances was used as a therapy for pulmonary tuberculosis. Jacobaeus mentioned that he planned to begin examination of the pleural cavity using Forlanini's treatment method (closed pneumothorax). This eventually led to the therapeutic application of thoracoscopy, which Jacobaeus himself initiated only a few years later in 1913 (Jacobaeus 1916), to facilitate pneumothorax treatment of tuberculosis by lysis of pleural adhesions by means of thoracocautery (Jacobaeus operation).

Jacobaeus therefore has to be regarded as the "father" of endoscopic procedures in serous cavities. Today, these techniques are widely used for diagnostic and therapeutic purposes by internists and surgeons. He was apparently aware neither of the above-mentioned publication in Ire-