THE METHOD OF MEDICAL THORACOSCOPY

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Cover image: Andreas Heine

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The Method of Medical Thoracoscopy

2nd Edition

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Historical Background

The idea of using optical instruments to enter and examine body cavities that cannot be accessed through a natural orifice dates back to the Dresden physician G. Kelling (1866–1945). As early as 1902, he published a report detailing how he was able to perform 'coelioscopy' in a dog after first insufflating air into the abdominal cavity. His optical system consisted of a cystoscope like the one previously developed by M. Nitze (1848–1906). Diagnostic thoracoscopy was first performed in human patients in 1910 by the Swedish internist H. C. Jacobaeus (1879–1937). The creation of a pneumothorax did not pose a new challenge for Jacobaeus, as C. Forlanini (1847–1918) had already developed the procedure in the late 1800s for the collapse therapy to treat tuberculosis. Jacobaeus advanced the capabilities of diagnostic thoracoscopy by the introduction of thoracocautery. This technique, which became important in the treatment of tuberculosis, used electrocautery for the lysis of pleural adhesions. By the end of the 1950s, thoracoscopy with thoracocautery was widely practiced in the collapse therapy of tuberculosis. Only a few clinicians utilized the diagnostic potential of thoracoscopy during that time; as a result, the diagnostic capabilities of thoracoscopy were largely forgotten.

The fascination of being able to look into the chest led R. Korbsch to state in 1927 that ‘in vivo pathology’ could be accomplished if gross visual findings could be supplemented by the histologic evaluation of biopsy specimens. The Viennese physician A. Sattler rediscovered the diagnostic value of thoracoscopy in the early 1960s. He performed thoracoscopies in several thousand patients, and we must credit him with making pleural biopsy practical for clinical use. He also performed thoracoscopy for therapeutic purposes and described life-saving emergency endoscopies for the treatment of hemothorax.

With the advent of video-assisted thoracoscopy in the 1980s, it also became possible to use thoracoscopy for surgical indications. Since then, video-assisted thoracic surgery (VATS) has become an established part of the thoracic surgical repertoire. At the same time, video-assisted thoracoscopy continues to be a mainstay in the medical diagnosis of diseases of the pleura, lung, and mediastinum.

2 Indications and Contraindications for Thoracoscopy

2.1 Indications

The range of indications for medical thoracoscopy has changed significantly in recent decades. The standard indications for medical thoracoscopy in the 1980s were unexplained pleural effusion, peripheral lung lesions, lesions near the chest wall, and mediastinal disease.

Today, tumors of the pleura, mediastinum and peripheral lung are diagnosed by CT- or ultrasound-guided biopsy. Generally these cases are not investigated by thoracoscopy. Interstitial lung diseases and peripheral lung tumors that cannot be diagnosed by bronchoscopic tissue sampling are a domain of thorascoscopic surgery. VATS can provide access for wedge resections that yield adequate material for histologic analysis. It is also used for the complete removal of solid peripheral lung lesions and isolated pleural tumors.

Diagnostic Indications for Thoracoscopy:

- Pleural effusions of unknown origin.
- Pleural effusions with negative cytology in lung cancer to exclude M1a disease (pleural carcinomatosis).
- Staging and histologic confirmation of pleural mesothelioma.
- Pneumothorax (prior to chest tube placement if indicated).
- Thoracoscopy in surgical cavities for a suspected tumor recurrence or specific infection.

In most cases thoracoscopy is performed during the investigation of pleural exudates that are not explained by cytologic examination. Interstitial lung diseases may be an indication for medical thoracoscopy in exceptional cases. In this application tissue is sampled from the periphery of the lung with a biopsy forceps. Generally speaking, however, a thorascoscopic wedge excision would be preferred for this indication.
In patients with a pneumothorax, thoracoscopy can supply vital information that is helpful in directing further management. It can be used to inspect the pleural cavity before the placement of a chest tube.\textsuperscript{16}

**Therapeutic Indications for Thoracoscopy:**

- Talc pleurodesis for rapidly recurring malignant effusions and for transudates unresponsive to medical therapy. In selected cases, the procedure may also be used in the treatment of chylothorax and refractory exudative inflammatory pleural effusions.\textsuperscript{15,29}
- Talc pleurodesis for recurrent pneumothorax.\textsuperscript{3,20}
- Pleural empyema and complicated parapneumonic effusions, where thoracoscopy can be used to evacuate the collection, lyse adhesions, and place a chest tube under vision.\textsuperscript{5,12,22,25,30}

Persistently recurrent pneumothorax with a chest tube in place is a definite indication for video-assisted thoracic surgery (VATS), which will also establish access for repairing the existing air leak.

Pleural empyema is a potential indication for medical thoracoscopy only if it is in an exudative or fibrinopurulent stage. Stage III disease is an indication for thoracic surgical intervention.

Thoracoscopy for pneumothorax as well as pleural empyema requires close interdisciplinary cooperation between pneumonology and thoracic surgery in developing a treatment strategy.

### 2.2 Contraindications

Thoracoscopy is generally well tolerated. We believe that it is contraindicated by conditions in which the creation of a diagnostic pneumothorax would exacerbate existing functional disorders.\textsuperscript{8,19} In patients with large pleural effusions that may cause respiratory insufficiency, however, functional status can be improved by aspirating the effusion during the procedure.

**Contraindications to Thoracoscopy:**

- Frank cardiac insufficiency.
- Frank pulmonary insufficiency.
- Coagulation disorder (Quick value < 60%, platelets < 80,000 Gpt/L).
- Dual antiplatelet therapy with aspirin and clopidogrel. A daily aspirin dose of 100 mg is not a contraindication in itself. Clopidogrel should be stopped approximately 1 week before the procedure.
- Treatment with dabigatran (Pradaxa\textsuperscript{®}), apixaban (Ellquis\textsuperscript{®}), or rivaroxaban (Xarelto\textsuperscript{®}). Cessation of these drugs should follow current recommendations.
- Anemia (Hb < 6 mmol/L).
- Severe kyphoscoliosis.
- Myocardial infarction during the previous 6 weeks.

### Anesthesia

Medical thoracoscopy is usually performed under local anesthesia, which should be combined with adequate conscious sedation. It is recommended that conscious sedation and patient monitoring during the procedure be conducted by an anesthesiologist or a physician experienced in conscious sedation who can quickly recognize and manage any threatening situations that may arise.

General anesthesia with muscle relaxation and intubation with a double-lumen endotracheal tube are rarely necessary for medical thoracoscopy and are generally reserved for children and uncooperative patients.
4 Preparations for Thoracoscopy

4.1 Imaging Studies

Preprocedure studies for thoracoscopy should always include PA and lateral chest radiographs. Thoracic computed tomography may yield important additional information, depending on the clinical question.

Thoracic ultrasonography is the method of choice for locating the optimal entry site. When pleural effusion is present, ultrasound can accurately determine whether there is sufficient space between the lung and chest wall to allow safe insertion of the trocar (Fig. 1). Ultrasound can also confirm the absence of chest-wall tumor at the trocar insertion site (Fig. 2). This ensures that the trocar will not penetrate metastases in the chest wall. Thoracic ultrasound also supplies information on the internal structure of the pleural effusion, including the presence of adhesions and the detection of loculations (Fig. 3). Especially in patients with small encapsulated pleural effusions, thoracic ultrasound can provide information on the size of the presumptive space available for thoracoscopy.

It is good practice to determine the optimal entry site with the patient in the lateral decubitus position. In patients with larger effusions, the potential entry site can also be determined and marked with bedside ultrasound.

4.2 Diagnostic Pneumothorax

Basically there is no need to create a diagnostic pneumothorax in patients with a large pleural effusion. When thoracoscopy is used in the investigation of smaller pleural effusions (Fig. 4) or lesions close to the chest wall, it is advisable to create a diagnostic pneumothorax. Once the pneumothorax has been established, it is easily determined whether there is sufficient space between the chest wall and lung surface to allow for safe intrathoracic access. If a diagnostic pneumothorax is not created, there is a risk of accidentally inserting the trocar into the lung if adhesions are present between the lung and chest wall.
The pneumothorax should be established immediately prior to thoracoscopy. The patient is positioned on the examination table with the healthy side down. After sterile skin preparation and draping of the affected side, local anesthesia with 10 mL of 1% lidocaine is performed in the fifth intercostal space in the midclavicular line or at another puncture site previously identified by ultrasound. When local anesthesia is completed, it should be determined whether the lung is broadly adherent to the chest wall. This is done by filling the needle hub with local anesthetic solution and then carefully advancing the needle through the chest wall. When the needle tip penetrates the parietal pleura and enters the pleural space, the fluid in the hub will be sucked into the chest by the negative intrathoracic pressure. Generally we leave the anesthesia needle in place for a short time so that atmospheric air can enter the pleural space through the needle (Figs. 5, 6).

With the local anesthesia needle removed, a stab incision is made and a Veress needle is introduced through the incision (Fig. 7). It is connected to a CO₂ insufflation pump (KARL STORZ Electronic Endoflator, Figs. 8, 9), which provides for microprocessor-controlled measurement and regulation of insufflation pressure and flow rate. A maximum intrapleural pressure limit of 2 mmHg should be set on the insufflation pump. The flow rate for CO₂ insufflation should be in the range of 0.5 to 1 L/min. The Electronic Endoflator also gives a numerical readout of the insufflated CO₂ volume.

When the Veress needle has penetrated the chest wall, the insufflator will give a negative pressure reading of -4 to -6 mmHg. If the needle tip is in the lung, the reading will fluctuate around zero. If this does not occur, it means that the needle is in the chest wall or that the pleural layers are obliterated. In this case we recommend moving to a different entry site because the pleural adhesion may be a local process confined to the initial port.
When a negative pressure reading is obtained, 100 mL of CO₂ is insufflated initially into the pleural space. If the pressure remains negative, the insufflation may be continued. During this time the Endoflator will give an intermittent reading of the current intrapleural pressure. If the pressure exceeds the maximum preset pressure level, CO₂ insufflation will stop automatically.

Occasionally, fresh pleural adhesions can be lysed by applying a slight overpressure (2 mmHg). A total of 600 to 800 mL of CO₂ should be insufflated into the chest cavity. We recommend using a C-arm fluoroscope to monitor the insufflation process. This allows the operator to track the progression of the diagnostic pneumothorax and see whether enough space has been established between the chest wall and visceral pleura to permit safe trocar insertion for thoracoscopy (Fig. 10). Alternatively, the insufflation can be monitored by chest radiography in the lateral position if a C-arm fluoroscope is not available (Figs. 11, 12).

Carbon dioxide insufflation is recommended for creating the pneumothorax because if a gas embolism should occur as a result of visceral pleural injury, the CO₂ will be quickly reabsorbed. This minimizes the risk to the patient. In cases where the pneumothorax is created the day before the examination, CO₂ should not be used because generally it will be completely absorbed by the scheduled procedure time on the following day.

### 4.3 Premedication

#### 4.3.1 The Evening Before the Procedure
Generally there is no need to premedicate patients on the evening before the procedure. Very anxious patients may take 5 mg of midazolam (Dormicum®) orally at night.

#### 4.3.2 The Day of the Procedure
Approximately 1 hour before the start of the procedure, the patient should be given an oral sedative such as midazolam (Dormicum®, 2.5–5 mg). If an anesthesiologist will be present during the procedure, he or she should determine the premedication.
**5 Technique of Thoracoscopy**

### 5.1 Procedure Room
Thoracoscopy should be performed in an operating room under aseptic conditions (as recommended by the German Robert Koch Institute).

### 5.2 Instruments
The following instrument set is required for thoracoscopy:
- Rigid thoracoscope (4-mm diameter, 30° HOPKINS® endoscope)
- Biopsy forceps*
- Suction tube*
- Powder dispenser*
- Dissecting electrode*
- Palpation probe
- Scalpel
- 2 flexible 6-mm trocars
- Tissue forceps
- Anatomical forceps
- Blunt scissors
- Suture material
- Needle holder
- 2 x 10-mL syringes with 1% lidocaine and hypodermic needle

*) compatible for use with the rigid thoracoscope

Fig. 13 shows the instrument stand ready for use.

### 5.3 Positioning the Patient
A rotating, tiltable operating table is essential for the optimum performance of thoracoscopy. The table should be fluoroscopy-compatible.

The patient is positioned in lateral decubitus with the healthy side down and padding beneath that side. An alternative option to padding the healthy side is to tilt the operating table at the thoracic level. The goal is to spread the ribs on the affected side as widely as possible by optimum positioning.

The patient’s arms are secured on arm rests to allow free access to the operative site. Anterior and posterior pelvic rests help to stabilize the position. During positioning, an electrode should be taped to the patient’s thigh to allow for the use of electrocautery devices, should they become necessary. The operator should make sure that the patient is lying in a comfortable position (Figs. 14, 15).

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13 Instrument set for thoracoscopy. (photo: Andreas Heine).

14 Patient positioning. The position is stabilized with pelvic and arm rests. A pelvic strap has been added for this patient. The entry site for thoracoscopy was previously identified sonographically and marked on the skin. ECG leads, a pulse oximeter sensor, and blood-pressure cuff have been placed.

15 Anterior pelvic rest

15 Posterior pelvic rest
5.4 Monitoring and Other Measures during the Procedure

Oxygen saturation is continuously monitored by pulse oximetry throughout the procedure. An ECG trace should be recorded to monitor cardiac rhythm, and blood-pressure readings should be taken at 5-minute intervals. Oxygen is administered by oronasal mask at a rate of 3–4 L/min. A secure IV line (20-gauge indwelling venous cannula) is placed for administering medications during the procedure.

5.5 Patient Preparation after Positioning

When the patient has been positioned, a sterile skin preparation is carried out around the proposed thoracoscopy site. Then the patient is completely covered with sterile drapes, leaving an approximately 30 x 30-cm field exposed for trocar insertion (Fig. 16).

5.6 Selection of the Entry Site

The selected entry site should give optimum access to the pleural lesion requiring biopsy. In patients with a large pleural effusion, the best entry site is determined by ultrasonography (Section 4.1). The effusion volume at the proposed site should be sufficient to allow safe trocar insertion. In patients with an encapsulated pleural effusion, an analogous technique is used to locate the site that offers sufficient clearance between the lung and chest wall. In patients with little or no pleural effusion or if a pneumothorax is present, the midaxillary line at the level of the fifth intercostal space is particularly favorable for obtaining a comprehensive view of the pleural cavity. The preliminary creation of a pneumothorax will enhance safety and facilitate the procedure.

5.7 Local Anesthesia

Local anesthesia is administered in layers by the intra- and subcutaneous injection of 1% lidocaine over an area of 2–3 cm within the intercostal space. Then the cranial and caudal rib margins are located, and depots of local anesthetic are placed along the rib margins bordering the intercostal space. Repeated aspirations are done to ensure that the needle does not enter a vessel. Next, local anesthetic depots are injected into the muscles and at the subpleural level. Air will be aspirated when the needle has pierced the costal pleura. At that point the needle is withdrawn with continuous aspiration until air is no longer obtained. This indicates that the needle tip is at the immediate subpleural level, and an additional depot of 3–4 mL lidocaine is placed in that region. Optimal local anesthesia is essential for a painless examination!
5.8 Conscious Sedation
Conscious sedation should be administered by a physician with comprehensive experience in that area. At our center, this responsibility is assumed by an anesthesiologist. The operator performing the thoracoscopy should not also be responsible for conscious sedation, so that he or she can devote full attention to the procedure. We recommend a titrated dose of midazolam and piritramide for conscious sedation, starting with an initial i.v. dose of 2–3 mg midazolam and 5 mg piritramide. An alternative analgesic is ketamine. Also, propofol (depending on response) may be given in combination with an analgesic.\textsuperscript{28}

5.9 Trocar Insertion
An approximately 8-mm skin incision is made along the intercostal space, and the chest is entered by blunt dissection with a scissors (Fig. 17). When the chest wall has been perforated, a flexible 6-mm trocar is inserted into the thoracic cavity with a corkscrew motion (Fig. 18). A whistling sound will generally be heard when the stylet is removed, confirming correct intrathoracic placement of the trocar. It is unnecessary to use trocars with a multifunction valve.

17 Blunt dissection with a scissors.
18 Flexible 6-mm trocar with a blunt metal stylet.
5.10 Inspection of the Thoracic Cavity

A 4-mm HOPKINS® endoscope (thoracoscope) with a 30° viewing angle is introduced into the chest through the flexible trocar. The endoscope should be warmed beforehand to prevent fogging. The examination begins with a systematic survey of the thoracic cavity. Once the survey is completed, a more detailed look is taken at suspicious areas or lesions. It may be necessary to tilt the operating table longitudinally or transversely to aid visualization of the posterior, anterior, apical and basal lung regions. A 30° endoscope allows the operator to inspect all portions of the chest cavity. It is particularly effective for evaluating lesions of the chest wall.

If a pleural effusion is present, it should definitely be aspirated from the pleural space prior to thoracoscopy to ensure good visualization. This can be done with an optical suction tube or a separate suction catheter.

The thoracoscopic images below illustrate a range of anatomic details, normal findings, and pathologic changes.
Inspection of the Right Hemithorax

24 Close-up view of the left subclavian artery (1) and vein (2) along with the internal thoracic artery and left internal thoracic veins (3). Left upper lobe (4), anterior chest wall (5).

25 View of the anterior chest wall displays the internal thoracic artery and veins (1). The surface of the left upper lobe (2) is visible on the right side of the field. The costal pleura appears smooth and shiny and shows normal vascularity.

26 Close-up view of the costal pleura, which appears normal. The yellowish areas are subpleural fat (1).

27 Close-up view of the left pleural dome displays the aortic arch (1), left subclavian artery (2), and the collapsed upper lobe (3) and lower lobe (4).

28 Pleural carcinomatosis involving the left parietal pleura. The velvety red appearance of the pleura is consistent with chronic pleuritis.

29 Pleural empyema.

30 View into the right hemithorax shows the “border triangle” formed by the junction of the middle lobe (1), lower lobe (2) and upper lobe (3). The visceral and parietal pleura appear thickened and fibrotic due to chronic fibrosing pleuritis.

31 View of the right cardiophrenic angle with the right atrium (1), diaphragm (2) and middle lobe (3).
5.11 Thoracoscopic Biopsy and Lysis of Adhesions

All lesions visible at thoracoscopy should be biopsied. This can be done with an optical biopsy forceps (Fig. 32). With diffuse pleural diseases, multiple pleural biopsies should be taken to obtain ample material from various sites. If the desired biopsy sites are not accessible through the initial portal, a second trocar can be inserted under local anesthesia and thoracoscopic guidance so that the necessary biopsies can be taken from that position. It is rarely necessary to add a second portal, however. Heavy bleeding from biopsy sites can be controlled by electrocautery with an optically guided hook electrode (Figs. 33, 34).

Biopsies can be taken from the parietal and visceral pleura as required. When tissue is sampled from the costal pleura, the area about the caudal rib margins should be avoided to prevent injury to intercostal vessels. If the visceral pleura is biopsied and an air leak occurs, it will generally close spontaneously within 7 days.

When adhesions are present, they can be cleared by side-to-side movements of the thoracoscope itself if they are very soft. Firmer adhesions can be divided with the hook electrode. As a note of caution, dense adhesions may transmit vessels of significant size that can bleed profusely if severed. If this complication arises, it may be necessary to create a second portal for hemostasis with a cautery probe or clip. Complicated parapneumonic effusions and pleural empyema may also require a second portal, through which adhesions can be lysed under vision with a probe. As a general rule, however, it is rarely necessary to create a second portal.
5.12 Talc Pleurodesis

The indications for talc pleurodesis are described in Sect. 2.1. It must be possible for the lung to expand fully and occupy all of the chest cavity. The expansibility of the lung is tested by introducing the thoracoscope and optical suction tube into the chest. The air is then suctioned from the chest while lung expansion is observed with the thoracoscope. Once the lung has expanded completely, it is ready for talc pleurodesis. Talcum powder is blown into the pleural space with an optical powder dispenser (Figs. 35–37). For effective pleurodesis, approximately 4 gr of talc is blown into the pleural cavity under thoracoscopic vision. The operator should make sure that all effusion has been aspirated from the chest prior to talc pleurodesis and that the entire lung and chest wall are coated with a thin film of talcum powder.

The talc should be applied in fractionated doses. Talc insufflation raises the intrathoracic pressure, and a potentially dangerous intrathoracic pressure rise is avoided by intermittently pausing the insufflation and removing the dispenser. Air escaping from the chest cavity makes an audible whistling sound.

Talc pleurodesis is a very effective procedure with a reported success rate of 83–93%. Even long-term studies have documented success rates higher than 80%. In recent years there have been efforts to replace talc pleurodesis with other procedures. Studies in relatively small case numbers have shown that the instillation of silver nitrate solution into the pleura can also induce pleurodesis. To date, there are no comprehensive studies showing that this technique is superior to talc pleurodesis.

35 Optical powder dispenser.
36 Talc pleurodesis with a powder dispenser under vision.
37 Intrathoracic view after talc application. The talc dust has been uniformly distributed over the lung surface.
5.13 Concluding the Procedure

At the end of the procedure, the entire pleural cavity should be carefully reinspected so that any bleeding from a biopsy or adhesiolysis can be detected and controlled. A 24-Charr. drain is then introduced into the pleura under vision. We recommend the preplacement of vertical mattress sutures after trocar removal. Then a 24-Charr. drain is passed through the trocar port into the chest cavity. During this time the drain should be stabilized with a probe passed into its lumen through a side hole in the drain. The probe is removed, and the 4-mm HOPKINS® endoscope is inserted into the drain lumen through a side hole and advanced until the interior of the chest cavity can be seen. Now the drain can be advanced posteriorly along a paravertebral path under direct visual control (Figs. 38–40). Next the thoracoscope is withdrawn, removing it completely from the drain. At this point the thoracoscope and drainage tube are in the original trocar port, so the thoracoscope can again be used to check the drain position and adjust it as needed. After the thoracoscope is removed, the drain can be secured with the preplaced suture. It is advisable to tie one knot, then wind the suture several times around the drain and tie a final knot. Next the chest wall is cleaned and an adhesive dressing is placed around the drain. The drain is connected to a suction pump. We prefer an electronic pump that also indicates airflow (Fig. 41).
Management after Thoracoscopy

Patients are monitored in the recovery room for 1–2 hours after thoracoscopy. A chest radiograph is obtained when the patient is returned to the floor. This is necessary to check for lung reexpansion and drain position. Adequate pain management is important after thoracoscopy. For this purpose, 50 mg pethidine may be given subcutaneously or 0.2–0.4 mg buprenorphine sublingually as needed. Following talc pleurodesis, care should be taken that the patient does not receive corticosteroids or NSAIDs as they would suppress the inflammatory response necessary for pleurodesis. Vital signs (pulse and blood pressure) should be taken hourly for the first 6 hours after the procedure. Nursing staff should make sure that the chest tube remains patent. Drain output and fluid appearance should be recorded and documented. When the output falls below 100 mL/24 hours, the drain may be removed. It is important to ambulate the patient immediately after thoracoscopy. Prophylactic antibiotics are unnecessary.

Complications

The complication rate after thoracoscopy is low. Our own studies indicate a rate of 2.34%. A total of 214 cases were reviewed. More recent studies also document the safety of thoracoscopy. Brins et al. (2012) report an infection rate of 10.5% in 57 cases (4 cases of pneumonia, 2 empyemas). This appears relatively high and is not consistent with our experience. The longer the drain remains in place, however, the higher the risk of infection. No thoracoscopy-related deaths have been reported.

Summary

Medical thoracoscopy is an economical, highly effective interventional procedure that can be learned quickly, has few complications, and permits the rapid and safe diagnosis of pleural diseases. This opinion is shared by many other authors. If necessary, thoracoscopy can also be used to investigate lesions in the peripheral lung and mediastinum. ‘Minithoracoscopy,’ which employs thoroscopes 2–5 mm in diameter, is also described by other authors as a highly effective, minimally invasive diagnostic procedure.

In recent years medical thoracoscopy has been increasingly applied for therapeutic purposes. It has a major role in the treatment of complicated parapneumonic pleural effusions and pleural empyema. At present, thoroscopic talc pleurodesis is the most effective and economical method that we have for inducing pleurodesis.
The Method of Medical Thoracoscopy

References


Instrument Set for Medical Thoracoscopy

Excerpts from the following catalogs:

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DOCUMENTATION AND ILLUMINATION
HEINE Instrument Set 6 mm

26072 BA

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26072 A

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26072 SU

**Optical Suction Tube,**
for use with HOPKINS® Telescope 26072 BA

It is recommended to check the suitability of the product for the intended procedure prior to...
The Method of Medical Thoracoscopy

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- **Cannula**
- **Trocar only**

**Plastic Cannula**, autoclavable, for flexible trocars, size 6 mm, package of 5

**VERESS Pneumoperitoneum Needle**, with spring-loaded blunt inner cannula, Luer-Lock, autoclavable, diameter 2.1 mm, length 10 cm
Instrument Set 11 mm

26038 AA  HOPKINS® Straight Forward Telescope 0°, with angled eyepiece, diameter 10 mm, length 27 cm, autoclavable, fiber optic light transmission incorporated, with 6 mm working channel

26120 J  VERESS Pneumoperitoneum Needle, with spring-loaded blunt inner cannula, Luer-Lock, autoclavable, diameter 2.1 mm, length 10 cm

30103 WX  Trocar, size 11 mm, color code: green-white, including:
Trocar only, with blunt tip
Cannula without valve, with insufflation stop-cock, length 8.5 cm,
Multifunctional Valve, size 11 mm

37470 SC  Coagulating and Dissecting Electrode, with suction channel, insulated sheath, with connector pin for unipolar coagulation, size 5 mm, length 43 cm

30804  Handle with Trumpet Valve, for suction or irrigation, autoclavable, for use with 5 mm coagulating suction tubes and 5 mm suction and irrigation tubes
The Method of Medical Thoracoscopy

**CLICKLINE MANHES Biopsy Forceps**, rotating, disassembling, insulated, with connector pin for unipolar coagulation, with Luer-Lock irrigation connection for cleaning, single action jaws, large jaws, size 5 mm, length 43 cm, including:
- **Plastic Handle**, without ratchet
- **Metal Outer Sheath**
- **Forceps Insert**

**Coagulation and Dissection Electrode**, L-shaped, with connector pin for unipolar coagulation, size 5 mm, length 43 cm

**Powder Blower**, with rubber bulb, straight sheath, size 5 mm, length 42 cm, including:
- **Sheath**
- **Rubber Bulb**
- **Tube**
- **Bottle**
Instruments for the Biportal Technique

**HOPKINS® Forward-Oblique Telescope 30°**, diameter 5 mm, length 29 cm, **autoclavable**, fiber optic light transmission incorporated, color code: red

**Trocar**, with blunt tip, flexible cannula, **autoclavable**, size 6 mm, working length 8.5 cm, color code: black, including:

- **Cannula**
- **Trocar only**

**Plastic Cannula, autoclavable**, for flexible trocars, size 6 mm, package of 5

**Coagulation Suction Tube**, with connector pin for unipolar coagulation, distally angled sheath, size 5 mm, length 28 cm, for use with Handle 30804

**Handle with Trumpet Valve**, for suction or irrigation, **autoclavable**, for use with 5 mm coagulating suction tubes and 5 mm suction and irrigation tubes
43249 DUP **CLICKLINE Biopsy Forceps**, dismantling, insulated, with connector pin for unipolar coagulation, distally angled outer sheath, single action jaws, jaws open vertically to angulation, size 5 mm, length 28 cm, including: **Plastic Handle**, axial, without ratchet, with 4 locking positions **Outer Sheath with Forceps Insert**

40775 LF **Dissecting Electrode**, L-shaped, insulated, with connector pin for unipolar coagulation, distally angled sheath, size 5 mm, length 28 cm

40491 TKU **Powder Blower**, with rubber bulb, distally angled sheath, size 5 mm, length 30 cm, including: **Sheath** **Rubber Bulb** **Tube** **Bottle**
**IMAGE1 S Camera System**

**Economical and future-proof**
- Modular concept for flexible, rigid and 3D endoscopy as well as new technologies
- Forward and backward compatibility with video endoscopes and FULL HD camera heads

**Innovative Design**
- Dashboard: Complete overview with intuitive menu guidance
- Live menu: User-friendly and customizable
- Intelligent icons: Graphic representation changes when settings of connected devices or the entire system are adjusted

**Automatic light source control**
- Side-by-side view: Parallel display of standard image and the Visualization mode
- Multiple source control: IMAGE1 S allows the simultaneous display, processing and documentation of image information from two connected image sources, e.g., for hybrid operations

**Dashboard**
- Complete overview

**Live menu**
- User-friendly

**Intelligent icons**
- Graphic representation

**Side-by-side view**
- Parallel display of standard image and Visualization mode

**Sustainable investment**
- Compatible with all light sources

**Modular concept for flexible, rigid and 3D endoscopy as well as new technologies**
- Forward and backward compatibility with video endoscopes and FULL HD camera heads

**Economical and future-proof**

**Forward and backward compatibility**
- With video endoscopes and FULL HD camera heads

**Compatible with all light sources**

**Sustainable investment**
- For hybrid operations
The Method of Medical Thoracoscopy

IMAGE1 S Camera System

Brilliant Imaging
- Clear and razor-sharp endoscopic images in FULL HD
- Natural color rendition

- Reflection is minimized
- Multiple IMAGE1 S technologies for homogeneous illumination, contrast enhancement and color shifting

FULL HD image

CLARA

FULL HD image

CHROMA

FULL HD image

SPECTRA A*

FULL HD image

SPECTRA B**

* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
The Method of Medical Thoracoscopy

**IMAGE1 S Camera System**

*NEW*

**TC 200EN**

**IMAGE1 S CONNECT**, connect module, for use with up to 3 link modules, resolution 1920 x 1080 pixels, with integrated KARL STORZ-SCB and digital Image Processing Module, power supply 100–120 VAC/200–240 VAC, 50/60 Hz including:

- **Mains Cord**, length 300 cm
- **DVI-D Connecting Cable**, length 300 cm
- **SCB Connecting Cable**, length 100 cm
- **USB Flash Drive**, 32 GB, USB silicone keyboard, with touchpad, US

*Available in the following languages: DE, ES, FR, IT, PT, RU

**Specifications:**

| HD video outputs | - 2x DVI-D  
| Format signal outputs | 1920 x 1080p, 50/60 Hz  
| LINK video inputs | 3x  
| USB interface | 4x USB, (2x front, 2x rear) 
| SCB interface | 2x 6-pin mini-DIN  
| Power supply | 100–120 VAC/200–240 VAC  
| Power frequency | 50/60 Hz  
| Protection class | I, CF-Defib  
| Dimensions w x h x d | 305 x 54 x 320 mm  
| Weight | 2.1 kg

For use with **IMAGE1 S**

**IMAGE1 S CONNECT Module TC 200EN**

**TC 300**

**IMAGE1 S H3-LINK**, link module, for use with IMAGE1 FULL HD three-chip camera heads, power supply 100–120 VAC/200–240 VAC, 50/60 Hz, for use with **IMAGE1 S CONNECT TC 200EN** including:

- **Mains Cord**, length 300 cm
- **Link Cable**, length 20 cm

**Specifications:**

| Camera System | TC 300 (H3-Link)  
| Supported camera heads/video endoscopes | TH 100, TH 101, TH 102, TH 103, TH 104, TH 106  
| LINK video outputs | 1x  
| Power supply | 100–120 VAC/200–240 VAC  
| Power frequency | 50/60 Hz  
| Protection class | I, CF-Defib  
| Dimensions w x h x d | 305 x 54 x 320 mm  
| Weight | 1.86 kg

---

*SPECTRA A: Not for sale in the U.S.*

**SPECTRA B: Not for sale in the U.S.**
**IMAGE1 S Camera Heads**

For use with IMAGE1 S Camera System

**IMAGE1 S CONNECT Module TC 200EN, IMAGE1 S H3-LINK Module TC 300**

and with all IMAGE1 HUB™ HD Camera Control Units

### TH 100

**IMAGE1 S H3-Z Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length $f = 15–31$ mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

<table>
<thead>
<tr>
<th>Specifications:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IMAGE1 FULL HD Camera Heads</strong></td>
</tr>
<tr>
<td>Product no.</td>
</tr>
<tr>
<td>Image sensor</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Optical interface</td>
</tr>
<tr>
<td>Min. sensitivity</td>
</tr>
<tr>
<td>Grip mechanism</td>
</tr>
<tr>
<td>Cable</td>
</tr>
<tr>
<td>Cable length</td>
</tr>
</tbody>
</table>

### TH 104

**IMAGE1 S H3-ZA Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, **autoclavable**, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length $f = 15–31$ mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

<table>
<thead>
<tr>
<th>Specifications:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IMAGE1 FULL HD Camera Heads</strong></td>
</tr>
<tr>
<td>Product no.</td>
</tr>
<tr>
<td>Image sensor</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
</tr>
<tr>
<td>Weight</td>
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<tr>
<td>Grip mechanism</td>
</tr>
<tr>
<td>Cable</td>
</tr>
<tr>
<td>Cable length</td>
</tr>
</tbody>
</table>
Monitors

19" HD Monitor, color systems PAL/NTSC, max. screen resolution 1280 x 1024, image format 4:3, power supply 100–240 VAC, 50/60 Hz, wall-mounted with VESA 100 adaption, including:
- External 24 VDC Power Supply
- Mains Cord

26" FULL HD Monitor, wall-mounted with VESA 100 adaption, color systems PAL/NTSC, max. screen resolution 1920 x 1080, image format 16:9, power supply 100–240 VAC, 50/60 Hz, including:
- External 24 VDC Power Supply
- Mains Cord
## Monitors

### KARL STORZ HD and FULL HD Monitors

<table>
<thead>
<tr>
<th>Wall-mounted with VESA 100 adaption</th>
<th>19”</th>
<th>26”</th>
</tr>
</thead>
<tbody>
<tr>
<td>9619 NB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9826 NB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Inputs:

<table>
<thead>
<tr>
<th></th>
<th>19”</th>
<th>26”</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fibre Optic</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

### Outputs:

<table>
<thead>
<tr>
<th></th>
<th>19”</th>
<th>26”</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

### Signal Format Display:

<table>
<thead>
<tr>
<th></th>
<th>19”</th>
<th>26”</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:3</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5:4</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>16:9</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Picture-in-Picture</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>PAL/NTSC compatible</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

### Optional accessories:

- 9826 SF **Pedestal**, for monitor 9826 NB
- 9626 SF **Pedestal**, for monitor 9619 NB

### Specifications:

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19”</th>
<th>26”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop with pedestal</td>
<td>optional</td>
<td>optional</td>
</tr>
<tr>
<td>Product no.</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
<tr>
<td>Brightness</td>
<td>200 cd/m² (typ)</td>
<td>500 cd/m² (typ)</td>
</tr>
<tr>
<td>Max. viewing angle</td>
<td>178° vertical</td>
<td>178° vertical</td>
</tr>
<tr>
<td>Pixel distance</td>
<td>0.29 mm</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Reaction time</td>
<td>5 ms</td>
<td>8 ms</td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>700:1</td>
<td>1400:1</td>
</tr>
<tr>
<td>Mount</td>
<td>100 mm VESA</td>
<td>100 mm VESA</td>
</tr>
<tr>
<td>Weight</td>
<td>7.6 kg</td>
<td>7.7 kg</td>
</tr>
<tr>
<td>Rated power</td>
<td>28 W</td>
<td>72 W</td>
</tr>
<tr>
<td>Operating conditions</td>
<td>0–40°C</td>
<td>5–35°C</td>
</tr>
<tr>
<td>Storage</td>
<td>-20–60°C</td>
<td>-20–60°C</td>
</tr>
<tr>
<td>Rel. humidity</td>
<td>max. 85%</td>
<td>max. 85%</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>469.5 x 416 x 75.5 mm</td>
<td>643 x 396 x 87 mm</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–240 VAC</td>
<td>100–240 VAC</td>
</tr>
<tr>
<td>Certified to</td>
<td>EN 60601-1, protection class IPX0</td>
<td>EN 60601-1, UL 60601-1, MDD93/42/EEC, protection class IPX2</td>
</tr>
</tbody>
</table>
Data Management and Documentation

KARL STORZ AIDA® – Exceptional documentation

The name AIDA stands for the comprehensive implementation of all documentation requirements arising in surgical procedures: A tailored solution that flexibly adapts to the needs of every specialty and thereby allows for the greatest degree of customization.

This customization is achieved in accordance with existing clinical standards to guarantee a reliable and safe solution. Proven functionalities merge with the latest trends and developments in medicine to create a fully new documentation experience – AIDA.

AIDA seamlessly integrates into existing infrastructures and exchanges data with other systems using common standard interfaces.

WD 200-XX*

AIDA Documentation System, for recording still images and videos, dual channel up to FULL HD, 2D/3D, power supply 100–240 VAC, 50/60 Hz

including:
- USB Silicone Keyboard, with touchpad
- ACC Connecting Cable
- DVI Connecting Cable, length 200 cm
- HDMI-DVI Cable, length 200 cm
- Mains Cord, length 300 cm

WD 250-XX*

AIDA Documentation System, for recording still images and videos, dual channel up to FULL HD, 2D/3D, including SMARTSCREEN® (touch screen), power supply 100–240 VAC, 50/60 Hz

including:
- USB Silicone Keyboard, with touchpad
- ACC Connecting Cable
- DVI Connecting Cable, length 200 cm
- HDMI-DVI Cable, length 200 cm
- Mains Cord, length 300 cm

*XX Please indicate the relevant country code (DE, EN, ES, FR, IT, PT, RU) when placing your order.
Workflow-oriented use

**Patient**
Entering patient data has never been this easy. AIDA seamlessly integrates into the existing infrastructure such as HIS and PACS. Data can be entered manually or via a DICOM worklist. All important patient information is just a click away.

**Checklist**
Central administration and documentation of time-out. The checklist simplifies the documentation of all critical steps in accordance with clinical standards. All checklists can be adapted to individual needs for sustainably increasing patient safety.

**Record**
High-quality documentation, with still images and videos being recorded in FULL HD and 3D. The Dual Capture function allows for the parallel (synchronous or independent) recording of two sources. All recorded media can be marked for further processing with just one click.

**Edit**
With the Edit module, simple adjustments to recorded still images and videos can be very rapidly completed. Recordings can be quickly optimized and then directly placed in the report. In addition, freeze frames can be cut out of videos and edited and saved. Existing markings from the Record module can be used for quick selection.

**Complete**
Completing a procedure has never been easier. AIDA offers a large selection of storage locations. The data exported to each storage location can be defined. The Intelligent Export Manager (IEM) then carries out the export in the background. To prevent data loss, the system keeps the data until they have been successfully exported.

**Reference**
All important patient information is always available and easy to access. Completed procedures including all information, still images, videos, and the checklist report can be easily retrieved from the Reference module.
Cold Light Fountain Power LED 175 SCB

20161420-1 Cold Light Fountain Power LED 175 SCB, with integrated SCB, high-performance LED and one KARL STORZ light outlet, power supply 110–240 VAC, 50/60 Hz
including:
Mains Cord

ENDOFLATOR® 40 with KARL STORZ SCB

with High Flow Insufflation (40 l/min.)

UI400S1 ENDOFLATOR® 40 SCB, Set, with integrated SCB module, power supply 100–240 VAC, 50/60 Hz
including:
ENDOFLATOR® 40
Mains Cord, length 300 cm
SCB Connecting Cable, length 100 cm
Universal Wrench
Insufflation Tubing Set, with gas filter, sterile, for single use, package of 5

Subject to the customer’s application-specific requirements additional accessories must be ordered separately.

* This product is marketed by mtp.
For additional information, please apply to:
*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46,
78579 Neuhausen ob Eck, Germany

DUOMAT®

Suction and Irrigation Pump

20321008 DUOMAT® Suction and Irrigation Pump, including:
DUOMAT®, power supply 100–120, 230–240 VAC, 50/60 Hz
Mains Cord
VACUsafe Promotion Pack Suction, 2 l
(not illustrated)

Subject to the customer’s application-specific requirements additional accessories must be ordered separately.

This product is marketed by mtp.
For additional information, please apply to:
*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46,
78579 Neuhausen ob Eck, Germany
Equipment Cart

**Equipment Cart**
wide, high, rides on 4 antistatic dual wheels equipped with locking brakes 3 shelves, mains switch on top cover, central beam with integrated electrical subdistributors with 12 sockets, holder for power supplies, potential earth connectors and cable winding on the outside,

**Dimensions:**
- Equipment cart: 830 x 1474 x 730 mm (w x h x d),
- shelf: 630 x 510 mm (w x d),
- caster diameter: 150 mm

**including:**
- Base module equipment cart, wide
- Cover equipment, equipment cart wide
- Beam package equipment, equipment cart high
- 3x Shelf, wide
- Drawer unit with lock, wide
- 2x Equipment rail, long
- Camera holder

**Monitor Swivel Arm,**
height and side adjustable, can be turned to the left or the right side, swivel range 180°, overhang 780 mm, overhang from centre 1170 mm, load capacity max. 15 kg, with monitor fixation VESA 5/100, for usage with equipment carts UG xxx
Recommended Accessories for Equipment Cart

**Isolation Transformer,**
200 V – 240 V; 2000 VA with 3 special mains socket, expulsion fuses, 3 grounding plugs, dimensions: 330 x 90 x 495 mm (w x h x d), for usage with equipment carts UG xxx

**Earth Leakage Monitor,**
200 V – 240 V, for mounting at equipment cart, control panel dimensions: 44 x 80 x 29 mm (w x h x d), for usage with isolation transformer UG 310

**Monitor Holding Arm,**
height adjustable, inclinable, mountable on left or right, turning radius approx. 320°, overhang 530 mm, load capacity max. 15 kg, monitor fixation VESA 75/100, for usage with equipment carts UG xxx