PHONOSURGERY
Principles and Techniques

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1. edition 2007
© 2015 Endo:Press® GmbH
P.O. Box, 78503 Tuttlingen, Germany
Phone: +49 (0) 74 61/1 45 90
Fax: +49 (0) 74 61/708-529
E-mail: Endopress@t-online.de

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Editions in languages other than English and German are in preparation. For up-to-date information, please contact Endo:Press® GmbH at the address shown above.

This text is based on the following publication:

Design and Composing:
Endo:Press® GmbH, Germany

Printing and Binding:
Straub Druck + Medien AG
Max-Planck-Straße 17, 78713 Schramberg, Germany

05.15-0.5

ISBN 978-3-89756-128-1
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1.0 Introduction

Phonosurgery is a collective term for surgical procedures aimed at restoring or enhancing the voice and improving verbal communication. A specific, function-oriented indication for these procedures has been accepted since the mid-20th century. Hans von Leden and Godfrey Arnold coined the term “phonosurgery” in 1963. The International Association of Phonosurgeons (IAP) established a consensus definition for the term in 2000:

“Phonosurgery” refers to function-oriented surgical procedures that are designed to improve, restore, or maintain the voice (and speech). Modern surgical procedures for the treatment of voice disorders are based on recent discoveries in the ultrastructure of the vocal folds and on the growing experience of many surgeons. Phonosurgery must meet criteria that are commensurate with the increased social and professional demands on the voice.

Four main types of procedures are practiced in modern-day phonosurgery:

- Phonomicrosurgery with direct or indirect access to the larynx
- Laryngoplasties
- Laryngeal injections
- Surgical reinnervation of the larynx

The impairment of communication or specific artistic voice skills has assumed greater importance in present-day society.

1.1 Basic Principles

1.1.1 Functional Microanatomy and Body-Cover Theory

The vocal folds are composed of various types of tissue: epithelium, lamina propria, striated muscle, nerves, vessels, and cartilage. The most important lesions from a phonosurgical standpoint are those involving the lamina propria. The membranous portion of the vocal folds is covered by squamous epithelium. The surface is raised into microridges, which apparently help to maintain the mucous coating, moisture, and shape of the vocal folds. The anterior and posterior commissures are lined by ciliated epithelium. Both types of epithelium are covered by a mucous blanket composed of two layers: a deeper watery serous layer and a more superficial mucinous layer. The mucinous layer prevents dehydration of the epithelial cells, while the serous layer allows for ciliary motion in the anterior and posterior commissures, permits contact between the vocal folds, and keeps the epithelium moist and pliable. Because of this arrangement, phonatory vibrations give rise to an undulating motion along the edges of the vocal folds called mucosal wave propagation. Adjacent epithelial cells are interconnected by desmosomes and are attached to the lamina propria by the anchoring collagen fibers of the basement membrane.

The most important vibratory structure is the epithelium. It gives shape to the vocal folds and enables them to return to their resting position. The vibrations of the vocal folds during phonation can be observed by stroboscopy, kymography and high-speed video recording.
The lamina propria is divided into a superficial, intermediate, and deep layer. The superficial layer of the lamina propria contains fewer elastin fibers than the other two layers. Elastic fibers are most abundant in the intermediate layer, while collagen fibers predominate in the deep layer. The vocal ligament is formed by the intermediate and deep layers of the lamina propria.

The extracellular matrix (ECM) of the lamina propria consists of fibrous proteins, glycosaminoglycans (polysaccharide chains) such as hyaluronic acid, and proteoglycans (proteins with a carbohydrate component) such as decorin, fibromodulin, and versican. The ECM transforms the aerodynamic energy of phonatory respiration into acoustic energy and helps the vibrating vocal folds return to their resting position. The metabolic processes in the ECM are mediated by enzymes, which are produced by fibroblasts.

The „body-cover model“ is an attempt to classify the connective-tissue structures of the vocal fold into functional units (Tab. 1). It groups the five anatomical tissue layers of the vocal fold into three functional layers: The first layer, called the cover, consists of the epithelium and superficial lamina propria. The second layer, called the transition, is the vocal ligament consisting of the elastic and collagen fibers of the intermediate and deep layers of the lamina propria. The third layer, called the body, consists of the vocalis muscle.

![Layers of the vocal folds: anatomical tissue layers compared with functional layers in the body-cover model](image)

<table>
<thead>
<tr>
<th>Layers of the vocal folds: anatomical tissue layers compared with functional layers in the body-cover model</th>
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<tbody>
<tr>
<td>Five tissue layers</td>
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<tr>
<td>Epithelium</td>
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<tr>
<td>Lamina propria</td>
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<td>Lamina propria</td>
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<tr>
<td>Lamina propria</td>
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<tr>
<td>Thyroarytenoid muscle</td>
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</table>

Fig. 0.1
Coronal section through the center of the membranous portion of the human vocal fold. The layered structure is described in Tab. 1.
1.1.2 Lesions of the Reinke Space

Vocal nodules, polyps, and Reinke edema result from epithelial changes that most commonly involve the superficial layer of the lamina propria and may also include the intermediate layer. Excessive vibrations during vocal abuse disrupt the structure of the basement membrane and superficial lamina propria.

In patients with vocal nodules, the chronic trauma leads to the deposition of type IV collagen and fibronectin on the vocal folds. In patients with Reinke edema, it leads to the formation of edematous lakes in the intercellular substance along with fibrin deposition with smaller amounts of fibronectin. There is no question that fibroblast activity in these pathological conditions is different from that in normal vocal folds, although we still know very little about the details of normal and abnormal cellular function in the vocal folds.

1.1.3 Auditory and Objective Evaluation of Dysphonia

The evaluation of voice quality and performance is a widely debated issue. At present there are no consistently reliable objective or subjective methods of voice evaluation that can be used to select patients for surgery, analyze the results of different treatments, assess the degree of functional impairment, or compare the results achieved by different surgeons or voice therapists working in different institutions and in different countries. The European Laryngological Society (ELS) has established a protocol that brings us one step closer to a generally accepted, valid method of voice evaluation.

It consists of a battery of voice tests comprising five dimensions:

- Auditory perceptual voice evaluation
- Videostroboscopy
- Electroacoustic analysis of the voice signal
- Aerodynamic measurements of phonation efficiency
- Subjective rating by the patient

Perceptual voice evaluation should be done by at least three judges to correct for interindividual differences among the listeners. The test is generally based on the voice qualities of roughness, breathiness, hoarseness, asthenia, strain, and instability using a four-point rating scale such as the GRBAS (overall grade, roughness, breathiness, asthenia, strain) or RHB system (roughness, breathiness, hoarseness). Videostroboscopy is used to evaluate glottic closure and vocal fold motion based on the amplitude of the paralyzed vocal fold and the mucosal wave propagation (normal or diminished). Key acoustic parameters are the voice volume during reading aloud, the dynamic range, the pitch range, and an electroacoustic analysis of variations in the fundamental frequency (jitter) and noise components. Clinically evaluable aerodynamic parameters are the maximum phonation time, glottic airflow, and subglottic pressure. Self-rating of the voice is obtained by having the patient complete a questionnaire (e.g., the VHI).

1.2 Goals of Voice Surgery

Voice disorders that are amenable to phonosurgical treatment fall into two etiologic categories: diseases in which abnormal tissue prevents normal vocal fold vibrations, and vocal fold movement disorders characterized by an abnormal position and/or tension of the vocal folds.

Generally a phonosurgical procedure should preserve or restore the functional structure of the vocal folds, giving particular attention to the following points:

- Respect the layered structure of the vocal folds
- Minimize tissue excision
- Minimize tearing of the superficial lamina propria
- Preserve the epithelium, especially along the freely vibrating edge of the vocal fold
2.0 Removal of Abnormal Tissue

Various pathological tissue changes can interfere with vocal fold vibrations:

- Epithelial lesions (e.g., papillomas, epithelial dysplasia, chronic laryngitis, carcinoma)
- Changes in the lamina propria (e.g., Reinke edema, nodules, polyps)
- Cysts (epidermoid cysts, retention cysts, pseudocysts)
- Sulcus, scar-tissue bands along the epithelium
- Atrophy, scar, defect
- Vascular changes (angiectasis, varices, hematomas)
- Arytenoid granulations (contact granuloma, intubation granuloma)
- Anterior webs (congenital, acquired, microwebs)

2.1 Phonomicrosurgery under Local Anaesthesia

The surgery of small epithelial and subepithelial changes in the vocal folds (up to 5 mm in size) can be performed in the conscious patient under local anesthesia\textsuperscript{21-25}. The patient is premedicated with morphine and atropine (10 mg morphine and 0.5 mg atropine s.c.), and the throat and larynx are topically anesthetized with tetracaine applied by spray and cotton swab. This permits the safe, painless removal of nodules, polyps, edema, small papillomas, as well as excisional biopsy under stroboscopic and auditory control (Fig. 0.2).

Ambulatory procedures can be done using a laryngeal mirror with an operating microscope or by using a rigid 70° or 90° telescope and observing the field directly or on a video monitor. Correct patient selection and technical proficiency will permit the precise removal of tissue abnormalities. With the growing pressure for outpatient day surgery, this technique will continue to be important and should be in the repertoire of every physician who practices phonosurgery.

2.2 Phonomicrosurgery by Direct Microlaryngoscopy

2.2.1 Technique

The advantages of direct microlaryngoscopy include a binocular stereoscopic view of the operative site, high magnification, a sharp image with excellent illumination, a relaxed patient, and a setting in which the surgeon can work calmly and with both hands. It is the most widely used approach in phonosurgery.

Ambulatory procedures can be done using a laryngeal mirror with an operating microscope or by using a rigid 70° or 90° telescope and observing the field directly or on a video monitor. Correct patient selection and technical proficiency will permit the precise removal of tissue abnormalities. With the growing pressure for outpatient day surgery, this technique will continue to be important and should be in the repertoire of every physician who practices phonosurgery.

Fig. 0.2 Removal of granulation polyps of the anterior commissure in an outpatient setting. Generally, the patient is premedicated with subcutaneous morphine and atropine. Tetracaine is used for local anesthesia. The surgeon watches a video monitor while operating. The operative site is exposed by videolaryngoscopy. Here, the surgeon is using a one-handed technique with a universal handpiece and cupped microforceps.

Fig. 0.3 Direct microlaryngoscopy. The larynx is visualized with a laryngoscope in the supine, intubated patient. The laryngoscope is suspended on a chest support, and the surgeon's arms are supported by arm rests. The operating microscope is used with a 400-mm objective lens and adjusted so that the surgeon can work with both hands.
There are no general guidelines for instrumentation, and various authors have developed their own instrument sets. Many surgeons use the Kleinsasser, Bouchayer, and Sataloff instruments as well as the special Abitbol laser microlaryngeal instruments. **Basic surgical techniques are listed below:**

- Grasping abnormal tissues with cupped forceps or flat heart-shaped graspers
- Incision with a scalpel
- Dissection of the epithelium and basement membrane with dissecting instruments
- Sharp division of the epithelium with scissors
- Controlled suction of mucus, pseudomyxoma, blood, and tissue residues
- Tissue vaporization with the CO$_2$ laser
- Tissue ablation with a shaver
- Hemostasis with monopolar cautery when the laser is not used or ineffective
- Suture placement with a needle holder, grasping forceps, and knot pusher
- The injection of augmentation material through a high-pressure laryngeal syringe (fat) or custom-trimmed butterfly catheter (collagen, hyaluronic acid).

Laryngoscopes are available in various designs. The latest models are particularly effective for exposing the anterior commissure and the larynx and its surroundings. As with any instrument, practical experience with a particular kind of laryngoscope will enable the surgeon to become more proficient in its use. Generally it is best to use a laryngoscope with the largest possible diameter. However, if visualization is found to be difficult, the use of a smaller laryngoscope normally facilitates exposure of the larynx (Fig. 0.5b).
The standard general anesthesia protocol consists of total intravenous anesthesia with propofol and remifentanil (Ultiva®), muscular relaxation with mivacurium chloride (Mivacron®), and endotracheal intubation. Jet ventilation offers no advantages in routine phonosurgical procedures\(^\text{29}\), although it may be an option in patients with cartilaginous lesions of the vocal fold. A transglottic jet catheter allows for optimum exposure while causing minimal passive movement of the glottis.

### 2.2.2 General Anaesthesia

Vocal nodules, polyps, and Reinke edema are primarily changes of the lamina propria that distend the overlying epithelium. Vocal cord nodules are completely removed (Fig. 1).

#### Figs. 1

Principle of the surgical removal of vocal nodules (after \(^\text{31}\)). The nodule (a) is marked by an elevation of the epithelium. It is resected tangentially with microscissors (b–d). The superficial layer of the lamina propria remains intact, and a minimal epithelial defect is formed (e).
Figs. 1.1a–e
Vocal nodules (a) are grasped with a cupped miniature forceps (d) triangular-jaws forceps (b) and excised with a microscissors (c). The epithelium does not close completely over the surgical defect (e), but the wound will heal without scarring if the lamina propria has not been damaged.

Measuring just 1–3 mm at their base, the nodules can be excised without special measures to preserve the epithelium. Polyps may be pedunculated with a narrow base or may be broadly sessile on the free edge of the vocal fold.

Pedunculated polyps, like vocal nodules, are treated by simple excision.

Sessile polyps are resected in a way that leaves some epithelium in place for wound coverage (Fig. 2). This method is also called the microflap technique or mini-microflap technique. Only excess epithelium is removed\textsuperscript{30-32}. 
Figs. 2
Principle of the surgical removal of vocal polyps (after 31). Vocal polyps are epithelial protrusions that are sharply demarcated relative to the surrounding vocal fold epithelium (a). The polyp is incised at its superolateral border (b). Excess subepithelial tissue and epithelium are excised (c, d), and the wound is covered with epithelium (e).

Figs. 2.1a–e
Vocal polyp (a) with a well-delineated border. The microscissors resection is done at the boundary between firm, healthy epithelium and the stretched, fragile epithelium of the protruding polyp (b–d). Sufficient epithelium is preserved for wound coverage (e).
The same principle is followed in the treatment of Reinke edema, which is removed in the subepithelial plane. The overlying epithelium is incised in the upper surface of the bulging vocal fold (b, c). The liquid or gelatinous intercellular material is suctioned (d) or extruded (e) from the lamina propria. Finally the redundant, stretched epithelium is resected (f) until the wound margins are smoothly apposed (g).
Reinke edema is covered by fragile epithelium and may be associated with a polypoid expansion (a). The resection is performed with a microscissors (b–d). The free edge of the vocal fold remains covered by epithelium (e). Removing too much epithelium is the most common error in surgical treatment of Reinke edema.

It should be noted that the epithelium is often very thin and tears easily when grasped with a microforceps. Thus, the surgeon should grasp the epithelium only on the upper surface of the vocal fold and place the incisions laterally in the Morgagni sinus where the Reinke edema terminates at the arcuate line. It is extremely important for vocal function that the free edge of the vocal fold retains its epithelial covering. Generally, there is no need to secure the flap with fibrin or an intralaryngeal suture, although such measures are occasionally recommended. Dissection of the epithelium should be carried out patiently and with great care. If the lamina propria is undamaged, the wound will heal without scarring. The epithelium will close and heal without loss of compliance or flexibility, and mucosal wave propagation will be restored.
In doubtful cases it is advisable to leave some of the edema behind. This is because insufficient closure of the membranous part of the glottis may well contribute to the pathogenesis of Reinke edema. The edema can compensate for this by helping to close the glottic gap. While patients may have a deep, harsh voice because of the edema, they should experience no vocal strain. Postoperative regression of edema will usually clear the harshness of the voice while preserving its deep quality. This may be an important prognostic factor in women who want to keep their low timbre.

The epithelium over the Reinke edema can easily be removed inadvertently at operation because it is very thin, fragile, and is attached to the distended, edematous upper layer of the lamina propria. The epithelium can easily be grasped and elevated with the microforceps, particularly if the edema is already organized and can be mobilized en bloc. Wound healing in this case will leave a smooth vocal fold, but the epithelium will be fixed to the vocal fold by scar adhesions and cannot vibrate, leading to severe, irreversible dysphonia. Unfortunately, this type of scarring is still relatively common and is extremely difficult to correct by additional surgery.

The same principle applies in the treatment of vocal fold cysts: it is essential to preserve the epithelium (Fig. 4).

Retention cysts, which arise from obstructed mucous glands, have a thin glandular epithelium that usually tears during surgical manipulations. Epidermoid cysts have a thicker epithelium that can withstand microsurgical dissection and enucleation.
Figs. 4.1a–h
Removal of a retention cyst in the right anterior commissure (a). This cyst developed following the removal of Reinke edema in which too much epithelium was resected, leading to scarring of the right vocal fold and moderately severe dysphonia. The cyst is opened with the microscissors (b, c) and its contents aspirated (d). Isotonic saline solution is injected beneath the scar tissue (e) to elevate the scar from the vocal fold, which bulges toward the midline (f). Corrections can be carried out in the distended tissue (g), allowing complete removal of the cyst and the elimination of redundant epithelium (h).
2.2.4 Papillomatosis

Laryngeal papillomatosis is an epithelial neoplasia caused by human papillomaviruses. Papillomas may cause a life-threatening airway obstruction, especially in children, by their progressive and sometimes rapid growth into the trachea and lungs. The most common symptom in adults is hoarseness. Radical removal is not possible because the viral DNA in the basal cells is not expressed at all sites following an infection. Infected basal cells are clinically indistinguishable from virus-free cells. While papillomatosis is not curable at present, it may enter long periods of remission. Treatment is symptomatic, therefore, and should be geared toward the preservation of function. The lesions can be resected least traumatically with a CO2 laser using a high power setting (7 W) and very short pulses (0.01 s). This method produces immediate hemostasis while causing minimal thermal injury to the lamina propria. Tissue removal in the true and false vocal folds should extend only to the level of the surrounding healthy epithelium or, with papillomas covering a larger area, should not go below the basement membrane into the deeper layers of the lamina propria. This avoids causing additional harm and helps to preserve vocal function until remission occurs. An alternative to the laser is the shaver (microdebrider). It should be noted, however, that the shaver may also cause scarring with consequent vocal dysfunction. Small exophytic papillomas can be removed under local anesthesia. Adjuvant therapies such as cidofovir (Vistide), photodynamic therapy, indole-3-carbinol, lithium succinate, cimetidine, imiquimod, and therapeutic vaccines may be used as an alternative or adjunct to surgical treatment. They have not yet provided an effective solution to the problem of papilloma recurrence, however.
2.2.5 Epithelial Dysplasia and Early-Stage Cancer

Laryngeal carcinoma is a potentially life-threatening disease. Treatment consists of radical surgical removal. In doubtful cases, the functional outcome is a less important concern than achieving a complete resection. Functional preservation is dependent on tumor size. Nevertheless, due consideration should still be given to functional aspects in the removal of premalignant lesions, carcinoma in situ, and early T1 tumors by applying microsurgical techniques and using the CO₂ laser. In the excision of dysplasia, subepithelial fluid injection is useful for protecting the intermediate and deep layers of the lamina propria in order to preserve phonatory function (Fig. 5).

Subepithelial injection is done to check for infiltrative growth and protect deeper layers of the lamina propria from thermal injury by the CO₂ laser (after 34).

Phonosurgical measures may be considered later if the carcinoma does not recur.
Additionally, subepithelial and sub-ligamentous resection techniques are available for use in patients with early-stage cancers (Figs. 6, 7, see p. 21). This makes it possible to preserve uninvolved structures (vocal ligament, vocalis muscle) that are important for phonation while also satisfying oncologic criteria.42, 43
Figs. 7
Subligamentous cordotomy (after 43).
The epithelium and vocal ligament are
removed, preserving the vocalis muscle.

Figs. 7.1a–b
Leukoplakia of the left vocal fold and
carcinoma of the right vocal fold (a). Subepithelial infusion is followed by
subligamentous laser resection of the
carcinoma down to the right vocalis
muscle and conventional removal of the
leukoplakic lesions on the left side (b).
The loss of tissue substance on the right
side is compensated by scarring. The left
vocal fold is still able to vibrate owing to
preservation of the lamina propria, enabling
postoperative phonation in the glottic plane.

2.2.6 Laser Surgery for Voice Improvement

Laser microsurgery is a major
advance in the treatment of laryngeal disorders. Even so, objections
have been raised since its introduction. The main arguments
against laser use related to thermal injury, charring, delayed wound
healing, and greater postoperative scarring44. These observations were
based on lasers with poor focusing properties and a focal spot size more than 1 mm in diameter45. Since then, impressive advances
have been made in laser technology46, permitting the laser beam to
be focused to microspot size with a focal spot of 0.25 mm or less.
The CO2 laser is particularly effec-
tive owing to its low penetration
depth, since infrared light energy at
a wavelength of 10.6 µm is strongly
absorbed in water. With modern
lasers, the zone of thermal damage
can be kept smaller than 50 µm.
This can be achieved by using very
short exposure times (≤ 0.01 s, or
10 milliseconds).
If a deeper cut is needed, the power level is increased. Delivering a rapid succession of high-power laser pulses is known as the ultrapulse or superpulse mode. A CO₂ laser operating in the "Q-switched mode" can emit very high peak power levels (up to 106 W) per picosecond. This mode can significantly reduce charring and thermal necrosis. A current system for laser beam guidance is the AcuBlade system, which can rapidly scan the highly focused laser beam along a designated path, resulting in minimal contact time and thermal injury.

This laser incision is comparable to a conventional scalpel cut in the depth of its effect. Owing to technological refinements, the laser has gained increasing acceptance as a phonosurgical instrument. Prospective randomized studies comparing laser surgery with conventional instrumentation have shown no significant outcome differences in terms of voice quality and healing rates.

A power output of 2–3 W may be adequate for lesions in the epithelium and lamina propria given the use of short exposure times. Muscle resections require up to 15 W of laser power. Bleeding is a minor concern in phonosurgery, as the hemostatic properties of lasers at the indicated settings are satisfactory for these procedures. The technical ability to limit the laser incision to the epithelium must be practiced to ensure that the zone of thermal damage does not extend too deeply. A surgeon using a laser for phonosurgery must be aware of these hazards in order to avoid functionally unfavorable scarring during reepithelialization.

3.0 Vocal Fold Mobility Disorders with Abnormal Position and/or Tension of the Vocal Folds

Surgery may be indicated in cases of vocal fold fixation due to paralysis or paresis or cricoarytenoid joint disease, neurological voice disorders such as tremor and spastic dysphonia, and laryngeal dysfunction that presents clinically with hyperfunction, hypofunction, or a false-vocal-cord voice. Neurogenic paralysis of the larynx may result from a central or peripheral lesion. The causative lesion of central paralysis may involve the first motor neuron, the extrapyramidal system, the cerebellum, cranial nerve nuclei (mainly the nucleus ambiguus), or multiple sites in the brainstem. Peripheral paralysis may result from lesions of the vagus nerve or its branches, the recurrent laryngeal nerve, or the superior laryngeal nerve. Dulguerov published the following breakdown of epidemiological data on the causes of laryngeal paralysis: 10% due to central neurologic diseases such as stroke, jugular foramen syndrome (Vernet syndrome), jugular foramen schwannoma, and Avellis syndrome ("laryngeal hemiplegia" due to peripheral glossoharyngeal and vagus nerve lesions or medulla oblongata infarction); 10% due to strumectomy or thoracodiastinal surgery; 40% due to tumors (esophagus); 10% posttraumatic; and 30% idiopathic. Ankylosis of the crico-arytenoid joint after vocal fold paralysis is rare.

Dysphonia due to unilateral vocal fold paralysis is a surgically treatable condition and is amenable to functional rehabilitation.

3.1 Laryngoplasties, Laryngeal Framework Surgery, and ISSHIKI Thyroplasties

The Phonosurgery Committee of the European Laryngological Society proposed the collective term "laryngeal framework surgery" as a synonym for laryngoplasty. These open surgical procedures involving an external approach through the neck are classified into four main types: approximation laryngoplasty, expansion laryngoplasty, relaxation laryngoplasty, and tensioning laryngoplasty.
3.1.1 Indications
The indication for surgery is based on the goal of enhancing the voice by improving glottic closure. If contact between the vocal folds is lost due to unilateral paralysis, the glottis will be unable to close during phonation. As a result, each of the vocal folds will vibrate at its own frequency, and the voice will have a harsh quality. An undesired falsetto voice may result from tension on the vocal fold due to partial innervation of the vocalis and cricothyroid muscles. Because glottic closure is incomplete, only a tangential airflow impinges on the vocal fold during phonation and energy is transferred ineffectually from the air stream to the vocal fold. The pitch of the speaking voice can be normalized by closing the glottic gap. Turbulent sounds, which are perceived as breathiness of the voice or even aphonia, are less common in recurrent laryngeal nerve palsy than laryngoscopic and stroboscopic findings in glottic insufficiency would suggest. Improving glottic closure also reduces the breathiness of the voice.

3.1.2 Symptoms
The cardinal symptom of unilateral paralysis is hoarseness. Dysphonia in a broader sense refers not just to voice quality but also to vocal abilities such as pitch range, intensity range, endurance, vocal strain, and the subjective rating of voice by the patient. Another important functional disorder that may occur in unilateral paralysis is dysphagia\(^6\)\(^\text{[6]}\). Dyspnea is a less significant concern\(^6\)\(^\text{[6]}\), as unilateral paralysis rarely causes dyspnea serious enough to require treatment.

3.1.3 Timing
An acute operation for vocal fold paralysis is performed within two weeks after the causative nerve lesion. An elective operation is performed up to six months after the onset of paralysis. Surgery for chronic paralysis is performed after six months\(^6\)\(^\text{[6]}\). The rule of waiting at least one year is no longer valid\(^6\)\(^{[6]}\). The reversibility of the laryngoplasty justifies this policy. Our own observations have shown that even when mobility is restored, residual lateral bowing of the vocal fold is not troublesome and does not require correction. Voice therapy is effective in stabilizing the laryngeal status, and residual innervation or reinnervation can improve the outcome. Medialization will facilitate voice exercises. If the patient is reluctant to consent to an operation, voice exercises should be prescribed to activate residual mobility and compensate for the phonatory impairment. It should be added that surgical intervention can be safely postponed, as it is still effective even years after the onset of paralysis\(^6\)\(^\text{[6]}\).

3.1.4 Complications
Edema and wound healing problems are rare. Infection can be prevented with perioperative antibiotics, but this is unnecessary as a routine measure. Tracheotomy\(^6\)\(^\text{[6]}\) is necessary in only a small percentage of patients (1%) whose paralysis is caused by a neck tumor or postoperative sequelae. If silicone has been implanted, it may occasionally evoke an allergic reaction that necessitates reoperation\(^\text{[6]}\). While this risk does not contraindicate all silicone injections, the availability of alternative materials does call into question the routine use of silicone. Complications that require surgical correction in 1–2% of cases are intraluminal extrusion of the implant\(^6\) and displacement of the cartilage shim. Mild compromise of respiratory function\(^\text{[6]}\) may occur after unilateral vocal fold paralysis and also after thyroplasty. This has no clinical significance as long as the patient avoids strenuous physical exertion. Other authors\(^\text{[6]}\) have been unable to document any respiratory compromise after thyroplasty. Dyspnea in a setting of unilateral vocal fold paralysis is still more of a theoretical than practical problem.
3.1.5 Medialization Thyroplasty

The most widely used method in approximation laryngoplasties is the medialization thyroplasty, which is based on the concept of moving the entire paralyzed vocal fold closer to the midline (Fig. 8 and Fig. 9). It is roughly equivalent to an Isshiki type I thyroplasty.

The medialization was originally accomplished by depressing the thyroid cartilage, as Payr first proposed in 1915. Variations involved the use of cartilage wedges or autologous cartilage from the upper part of the thyroid cartilage. Isshiki later advocated the placement of a silicone implant carved to the necessary size and shape. Other medialization materials include ceramic wedges made of hydroxylapatite, Gore-Tex sheets, plastic wedges from the Montgomery Thyroplasty Implant System, and the Friedrich Titanium Implant System.
Thyroplasty for recurrent laryngeal nerve palsy on the left side. The thyroid cartilage is exposed, and the proposed window is outlined with a scalpel (a). The cartilage is divided with a cutting burr (b). The piece of cartilage is mobilized and pushed medially with a periosteal elevator (c). The inner perichondrium is left intact. The superior border of the thyroid cartilage is freed of perichondrium (d). A cartilage strip is excised with a scissors (e, f) and inserted crosswise into the thyroplasty window (g) to maintain the position of the medialized piece of cartilage (h). The stabilized cartilages can be secured with Histoacryl glue (i), which fills in the window to the level of the thyroid lamina.
3.1.6 Arytenoid Adduction

Arytenoid adduction\(^{63, 88-90}\) moves the vocal fold medially by rotation of the arytenoid cartilage (Fig. 10). It is effective in cases with a broad interarytenoid gap and is performed in conjunction with a medialization thyroplasty. Arytenoid adduction lengthens the total operating time by approximately 30 minutes. The muscular process of the arytenoid cartilage is accessible through the thyroid cartilage by resection, incision and disarticulation of the cricoarytenoid joint\(^9\) or through a separate posterior window\(^{91}\).

3.1.7 Other Types of Laryngoplasty

Other types of laryngoplasty are mentioned here only for completeness, as they have few clinical indications. Nevertheless, they should be part of every phonosurgeon’s repertoire.

Expansion laryngoplasty can be used in the treatment of excessive glottic closure like that occurring in adductor-type spastic dysphonia.

Relaxation laryngoplasty reduces tension on the vocal folds in the anteroposterior direction and lowers the voice in patients with a mutational voice disorder or vocal fold stiffness due to scarring.

Tensioning laryngoplasty is used to tighten stretched, lax vocal folds or to raise voice pitch in patients with cricothyroid paralysis and in male-to-female transsexuals\(^{58}\).

---

Fig. 10
Principle of arytenoid adduction as described by Isshiki\(^9\). The arytenoid cartilage is dislocated and the muscular process is pulled forward to rotate the vocal process medially. It is stabilized with a nonabsorbable suture placed in the anterior margin of the thyroplasty window. This permits glottic closure in the membranous portion of the vocal fold.

Figs. 10.1a–d
The muscular process of the arytenoid cartilage is accessed through a posterior cartilage window, snared with a suture (a), and pulled forward (b). The arytenoid cartilage is connected to the membranous vocal fold by the vocal process (c). The anterior traction rotates the arytenoid cartilage, tightens the vocal fold, and displaces it medially (d).
3.2 Surgical Reinnervation of the Vocal Folds

The ansa cervicalis has been anastomosed to the recurrent laryngeal nerve for laryngeal reinnervation in experimental animals. Voice improvement in human patients has also been reported with this technique. The paralyzed and "reinnervated" vocal fold remained fixed during respiration, but the authors found that the increased muscular tension did improve postoperative phonation. The operation, which involves exposing the ansa cervicalis and anastomosing it to the anterior branch of the recurrent laryngeal nerve, is complicated and not widely practiced.

3.3 Augmentation Injections

The simplest and most frequently used medialization techniques are those in which augmentation material is injected into the vocal fold to decrease the glottic gap. They may be performed under local or general anesthesia. When local anesthesia is used, the patient is awake and seated in front of the surgeon. The larynx is visualized with a rigid endoscope or laryngeal mirror. Local anesthesia is achieved with 1% tetracaine mixed with epinephrine for vasoconstriction and a detergent (Tacholiquin) for better wetting of the mucosa. When general anesthesia is used, the larynx is exposed with the laryngoscope. General anesthesia is preferred in less cooperative patients. The injection is performed with special needles appropriate for the type of material used. A 23-gauge butterfly needle is best for injecting hyaluronic acid, and a 27-gauge needle is best for collagen. Fat can be injected through a needle with a 1.2-mm lumen attached to a Brüning syringe. Jet ventilation with a narrow tracheal catheter makes it easier to observe the effect of the injection. If endotracheal intubation is necessary, the smallest possible tube size should be used. The material is injected directly into the vocal fold. The needle is inserted either into the lateral part of the vocalis muscle or into the space between the thyroid cartilage and vocalis muscle. Material should not be injected into Reinke’s space beneath the vocal fold epithelium (Fig. 11), provided the layers are not scarred or absent. The more viscous the material, the closer it can be placed to the free edge of the vocal fold.

![Figs. 11](image-url)
Site for injecting augmentation material into the vocal fold.

a - Incorrect injection site,
b - Correct injection site (after Hirano).
Figs. 11.1a–g
The left vocal fold is fixed and the vocalis muscle is atrophic (b). An elliptical glottic gap is present during phonation (a). Collagen (Zyplast) is injected lateral to the fixed cord behind the vocalis muscle (c). When the procedure is done under local anesthesia as shown here, the surgeon can monitor the effect of the injection by having the patient vocalize (d). Some overcorrection is necessary to allow for absorption of the collagen (e). Glottic closure is still complete following collagen absorption (f). The injection has straightened out the previously bowed edge of the vocal fold (g).
3.3.1 Materials

**Fat**\(^{96-103}\): Of the various injectable biomaterials, which differ in their viscosity\(^{104, 105}\), autologous fat has the most favorable properties.

**Teflon:** Although this material is still mentioned in the literature\(^{106}\), injectable Teflon has serious disadvantages (see below) and should no longer be used.

**Collagen**\(^{107-115}\): Collagen produced from bovine skin or homologous acellular collagen\(^{116, 117}\) is convenient to use and provides immediate good results. The absorption rate cannot be determined precisely for any given case, but a good general estimate is a 40–60% volume loss.

**Hyaluronic acid**\(^{105, 118-121}\): Hyaluronic acid is an insoluble compound with good viscoelastic properties. It is still detectable up to 12 months after injection and is permeated by connective tissue ingrowth (collagen, fibroblasts). The injection of hyaluronic acid yields somewhat better results than collagen injection.

**Fascia lata**\(^{122-127}\): Fascia lata can be cut into small pieces and injected into the vocal fold. The autologous material is transformed into connective tissue and is tolerated without signs of an inflammatory or foreign-body reaction. Its effect is comparable to that of other implant materials.

3.3.2 Disadvantages of the Injection Technique

The injection may cause damage to the epithelium, vocalis muscle, or lamina propria. Potential problems include tissue induration, abscess formation at the injection site, hypersensitivity reaction to bovine collagen, or the induction of vascular changes\(^{116}\) resulting in a deterioration of auditory, aero-dynamic and endoscopic findings\(^{128}\). While poor results are not inevitable\(^{129}\), the mechanical compression of the lamina propria will necessarily impair the vibration properties of the epithelium. This risk should be considered before the intervention.

Teflon injection is of purely historical interest today. It has been largely abandoned because granuloma formation\(^{130}\), implant displacement, and uncorrectable faulty placement\(^{131, 132}\) can spoil the intended outcome of voice improvement.
3.3.3 Reconstruction of Glottic Defects after Endolaryngeal Tumor Surgery

The dysphonia following a partial laryngectomy, usually done for malignant disease, is determined by the extent of the resection and the size of the resulting defect. This type of surgery leads to the formation of rigid intralaryngeal scars. In favorable cases the surgery leaves tissue with good vibrational properties on the non-operated side. Glottic closure is incomplete, and the patient develops compensatory vocal habits, usually consisting of speech in the supraglottic plane (false-vocal-fold voice). The indications for phonosurgery are a broad glottic gap, persistent dysphonia despite voice therapy, and subjective patient dissatisfaction. The functional deficits may consist of an aphony voice, excessive air consumption during speech, strenuous vocal effort, and swallowing difficulties.

The basic principle of vocal fold reconstruction is to move the tissue on the operated side toward the midline. This can be done with the methods described above: medialization through an extralaryngeal approach or endolaryngeal microsurgery using advancement flaps and augmentation through a laryngoscope.

Although these techniques cannot eliminate hoarseness and restore a normal voice, they can achieve significant improvement of dysphonia in most patients. Air consumption is reduced, resulting in increased phrase length and subjective voice improvement. Barring pathological findings at the operative site (leukoplakia, inflammation, granulation), reconstructive surgery can be attempted 6–12 months after tumor surgery. This operation will not interfere with oncologic follow-up.

Figs. 11.2a–d
Glottic defect following a laser cordectomy on the left side (a). Phonation occurs in the plane of the ventricular folds (b), resulting in a false-vocal-fold voice. Below the opposing ventricular folds, there is absence of contact between the intact right vocal fold and the scar on the left side. The defect was augmented and reconstructed by thyroplasty, the implantation of septal cartilage grafts, and flap advancement (c). This combination of procedures restored phonation to the glottic plane (d).
3.4 Bilateral Vocal Fold Paralysis, Glottic Widening and Voice Function

Bilateral vocal fold paralysis raises the problem of respiratory distress. Widening the glottis to improve breathing will inevitably cause impairment of phonation. Of the variety of methods available (reviewed in [133]), partial arytenoidectomy and posterior cordectomy with the CO₂ laser have proven most advantageous [72, 134, 135]. Only the part of the arytenoid cartilage projecting into the laryngeal lumen is resected. This prevents fluid aspiration without causing additional swallowing difficulties. Since the anterior part of the membranous portion of the vocal fold is preserved, some vibrating tissue is still available for phonation (Fig. 12).

Even with meticulous operating technique, it is impossible to predict vocal function after glottic widening surgery. It is clear, however, that the surgery does cause vocal impairment and that voice quality will depend on the compensatory capacities of the individual patient. These include the remaining innervation of the vocalis muscle by the anterior branch of the recurrent laryngeal nerve or ansa galeni and the ability to acquire a false-vocal-fold voice. The operating technique can contribute to preserving these residual functions. A complete cordectomy is unfavorable for voice preservation and almost invariably leads to aphonia.

Figs. 12
Principle of partial arytenoidectomy and posterior cordectomy with intralaryngeal sutures. (b) The intraluminal part of the vocal process of the arytenoid cartilage is resected by laser surgery, and the incision through the conus elasticus is extended laterally to the cricoid cartilage. (c) The posterior part of the vocal fold is opened with a triangular incision, and the underlying vocalis muscle is resected. (d) The inferiorly based flap from the posterior part of the vocal fold is sutured laterally to the ventricular fold. This creates optimum conditions for wound healing (e) with minimal fibrin and granulation tissue formation. If the anterior part of the vocal fold can still be adducted, it can be utilized for phonation [134].
Bilateral paralysis of the vocal folds in a paramedian position (a). The operation can be performed under general endotracheal anesthesia or jet ventilation. A tracheotomy is not mandatory. The first incision, the cordotony, is made transverse to the glottis at the vocal process of the arytenoid cartilage (b), dividing the conus elasticus as far as the upper cricoid cartilage. The triangular opening is produced by retraction of the vocalis muscle. The part of the arytenoid cartilage projecting into the lumen is excised with the laser (c). This requires no additional aids since the arytenoid cartilage generally is not ossified. The posterior part of the vocal-fold muscle is resected with the laser (d). This resection is called a partial posterior cordectomy. Inferiorly, the conus elasticus with its mucosal covering remains intact below the membranous part of the vocal fold. This inferiorly based flap is fixed laterally with intralaryngeal sutures using a micro-needle holder and a small grasping forceps (e–g). The suture material consists of an absorbable, braided, atraumatic 5–0 suture 75 cm long. The knot is pushed downward with a knot pusher (h) to permit approximation of the wound margins. The number of sutures depends on the length of the resection (i, k).
4.0 Discussion

Voice quality and vocal efficiency after phonosurgical procedures cannot be evaluated based on a direct comparison of absolute values measured by different authors due to variations in measuring conditions at different institutions. Vocal fold lesions that have been operatively treated under microlaryngoscopic control are functionally evaluated based on voice performance. Function is the reason for the operation, and hence the goal of surgery is functional improvement. The patient must be given the choice of whether or not to have the operation, and he should not regret his consent at a later time.

For every head and neck surgeon with a sufficiently self-critical attitude, any procedure done for benign lesions without dyspnea or dysphagia that results in a deterioration of voice quality must be considered a failure. Scrupulous patient selection, meticulous technique, and appropriate resections and corrections will help to prevent irreversible damage. By definition, vocal function is the main priority in phonosurgery. If an operation does not yield the desired result, it should be possible to proceed with a second operation to effect further improvement.

For the present, we cannot state definitively whether vocal-fold medialization by a thyroplasty or augmenting injection will generally yield the best voice outcome. High success rates of phonosurgical medialization have been reported for the methods described above\(^{10, 64, 136}\). They depend chiefly on how well the mobile phonatory structures, lamina propria, and epithelium have been preserved and on the quality and completeness of glottic closure. Medialization procedures leave the vocal fold intact. While this represents an advantage over injection techniques, the latter can completely compensate for residual glottic insufficiency\(^{138}\).

Post-strumectomy lesions account for the highest percentage of cases of vocal fold paralysis that require surgical treatment. But prevention is better than treatment. It has been shown that microdissection technique and intraoperative nerve monitoring can reduce the incidence of vocal fold paralysis to less than 1%\(^{137}\). If this trend continues, there will be less need for the functional rehabilitation of iatrogenic paralysis in the future.

The contribution of reinnervation to surgical success rates is uncertain. Even a partial return of nerve function will improve voice quality, either by improved respiratory mobility or by innervation of the intrinsic laryngeal muscles, which do not atrophy and, consistent with the body-cover model, provide a solid foundation for epithelial movements on the lamina propria.

Physicians, patients, and third parties generally agree that voice quality is improved after phono-surgery. Thus, a pre- and post-operative comparison of voice quality is useful for determining whether available diagnostic methods can detect significant changes, i.e., whether they are valid. The protocol of the European Laryngological Society\(^{8}\) can serve as a model in this regard, emphasizing the need to establish a battery of simple but powerful multidimensional tests for evaluating the abnormal voice (see the section on Auditory and Objective Evaluation of Dysphonia).

At present, the various tests are usually considered in isolation but actually relate to different, independent aspects of the voice. In this sense they comprise an interrelated network\(^ {139} \). The goal of multidimensional voice testing is the ability to categorize the degree of voice impairment as normal (0–4%), mild (5–24%), moderate (25–49%), severe (50–95%), or complete (96–100%) based on the International Classification of Functioning, Disability and Health (ICF)\(^ {140} \). A uniform diagnostic protocol that collects valid, reliable data is essential for evidence-based studies. It is up to phoniatrists to develop this protocol.
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**Recommended Instrument Set for Endolaryngeal Phonomicrosurgery**

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Instrument</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>8590 A</td>
<td>KLEINSASSER Operating Laryngoscope,</td>
<td>for adults, extra large, length 17 cm</td>
</tr>
<tr>
<td>8590 B</td>
<td>Same, large</td>
<td></td>
</tr>
<tr>
<td>8590 C</td>
<td>Same, medium, length 17 cm</td>
<td>(most commonly used model)</td>
</tr>
<tr>
<td>8590 DN</td>
<td>Same, small, length 18 cm</td>
<td>(for particularly difficult anatomical circumstances)</td>
</tr>
<tr>
<td>8590 J</td>
<td>Same, medium, length 18 cm</td>
<td>(for anterior commissure)</td>
</tr>
<tr>
<td>8590 JL</td>
<td>Same, medium, length 22 cm</td>
<td>(for especially long neck)</td>
</tr>
<tr>
<td>8590 K</td>
<td>Same, for children, small, length 15 cm</td>
<td></td>
</tr>
<tr>
<td>8590 L</td>
<td>Same, for infants, small, length 13 cm</td>
<td></td>
</tr>
<tr>
<td>8589 C</td>
<td>RUDERT Anterior Commissure Laryngoscope,</td>
<td>medium, universal size, triangular spatula-shaped, with lateral outer channels for Fiber Optic Light Carrier 8574 LF or Suction Tube to remove vapor 8574 LM, length 17 cm (most commonly used model)</td>
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<tr>
<td>8587 A</td>
<td>LINDHOLM Operating Laryngoscope,</td>
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<td>8587 GF</td>
<td>Fiber Optic Light Carrier,</td>
<td>for distal illumination, length 7.5 cm, for use with Laryngoscopes 8587 A/AA/KK</td>
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<td>KLEINSASSER Forceps,</td>
<td>straight, with 2 mm cupped jaws, with cleaning connector, working length 23 cm</td>
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<td>Same, curved to right</td>
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<tr>
<td>8591 D</td>
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<td>KLEINSASSER Scissors,</td>
<td>straight, with cleaning connector, working length 23 cm</td>
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<td>8594 D</td>
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<td>KLEINSASSER Grasping Forceps,</td>
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<td>8593 G</td>
<td>Same, with triangular jaws,</td>
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<td>8593 H</td>
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<td>8595 C</td>
<td>KLEINSASSER Knife,</td>
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<td>Elevator,</td>
<td>slightly curved, working length 23 cm, for use with Handle 8597</td>
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<td>KLEINSASSER Knot Tier,</td>
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<td>8597</td>
<td>KLEINSASSER Handle,</td>
<td>for use with 8595 A – 8596 T, 8655 A – K, 8693 A/B</td>
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</table>

**Additional Instruments**

- **KLEINSASSER Needle Holder**, straight, small model, for phonosurgery and endolaryngeal microsurgery, 1.8 x 3.5 mm jaws with cross serration, without ratchet, sheath reinforced from distal to proximal, with cleaning connector, working length 20 cm
- **KLEINSASSER Needle Holder**, delicate, straight, serrated jaws, size 1.8 x 3.5 mm, sheath conically reinforced from distal to proximal end, with ratchet, with cleaning connector, working length 23 cm
- **Universal Handle**, forceps shape, with 2 handle rings, length 9 cm, for use with 3 mm instruments for phonosurgery and endolaryngeal microsurgery 8595 A – 8596 T, 8655 A – K and 8656 A – S
- **Suction Tube**, handle with cut-off hole, tip with central opening, outer diameter 1.5 mm, working length 20 cm
- **Miniature Grasping Forceps**, extra delicate, serrated, with triangular jaws, curved upwards to right, with cleaning connector, working length 23 cm
- **Same**, curved upwards to left
- **KLEINSASSER Miniature Scissors**, curved to right, with cleaning connector, working length 23 cm
- **Same**, curved to left
- **Sickle Knife**, straight cutting, delicate, 3 to 1 mm tapered shaft, total length 23 cm
- **Elevator**, slightly curved, blunt, delicate, 3 to 1 mm tapered shaft, total length 23 cm
- **Same**, sharp tip
- **Micro Forceps**, straight, with 1 mm cupped jaws, with cleaning connector, working length 20 cm
- **Same**, curved to right
- **Same**, curved to left
- **SHAPSHAY-PERETTI Micro Grasping Forceps**, curved upwards to right, serrated, with triangular fenestrated jaws, with cleaning connector, working length 20 cm
- **Same**, curved upwards to left
- **Micro Grasping Forceps**, curved to left, serrated, with cleaning connector, working length 20 cm
- **Same**, curved to right
- **Micro Scissors**, straight, with cleaning connector, working length 20 cm
- **Same**, curved to right
- **Same**, curved to left
- **Indirect Laryngeal Forceps**, for biopsy, curved upwards, spoon diameter 4 mm, with cleaning connector, working length 17 cm
- **PELTESON Cotton Applicator**, working length 27 cm
- **FEHLAND-NAWKA Needle Holder**, with crosswise recess for holding the butterfly needle, for indirect injection into the larynx, with ratchet, angled 90° to the right, with cleaning connector, working length 23 cm
- **Same**, with ratchet, angled 90° to the left
**Original KLEINSASSER Operating Laryngoscopes**

Full size illustration: inner diameter in mm proximal and distal

![Diagram of laryngoscopes](image)

- **8590 A**  
  KLEINSASSER Operating Laryngoscope, for adults, extra large, length 17 cm

- **8590 B**  
  Same, large

- **8590 C**  
  Same, medium  
  (most commonly used model)

- **8590 DN**  
  Same, small, length 18 cm (for particularly difficult anatomical circumstances)

- **8590 J**  
  Same, medium, length 18 cm  
  (for anterior commissure)

- **8590 JL**  
  Same, medium, length 22 cm  
  (for especially long neck)

- **8590 K**  
  Same, for children, small, length 15 cm

- **8590 L**  
  Same, for infants, small, length 13 cm

- **8590 GF**  
  Fiber Optic Light Carrier, for distal illumination, working length 14 cm,  
  for use with Laryngoscopes 8588 BV, 8590 A-JN, 8590 T, 8590 JV/TV and Diverticuloscopes 12067 A, 12068 A

- **8590 HF**  
  Fiber Optic Light Carrier, for distal illumination, working length 7.5 cm,  
  for use with Laryngoscopes 8590 K – L

It is recommended to check the suitability of the product for the intended procedure prior to use.
**RUDERT Anterior Commissure Laryngoscope**

Full size illustration: inner diameter in mm proximal and distal

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**8589 C**

RUDERT Anterior Commissure Laryngoscope, medium, universal size, triangular spatula-shaped, with lateral outer channels for Fiber Optic Light Carrier 8574 LF or Suction Tube to remove vapor 8574 LM, length 17 cm (most commonly used model)

**8574 LF**

Fiber Optic Light Carrier, for distal illumination, length 16 cm, for use with Laryngoscopes 8590 AL/BL/C/CL/DL/JA and 8589 B/C

**8574 LM**

Insertable Suction Tube to remove vapor, for use with laryngoscopes 8590 BL/CL/JA and 8590 C, length 16 cm
Original LINDHOLM Operating Laryngoscopes

8587 A  LINDHOLM Operating Laryngoscope, large, for adults, inner proximal end 39 x 24 mm, distal end width 18 mm, length 15 cm

8587 GF  Fiber Optic Light Carrier, for distal illumination, length 7.5 cm, for use with Laryngoscopes 8587 A/AA/KK

8587 M  Suction Tube to remove vapor, for LASER treatment, length 8.5 cm
Instruments for Large Lesions

8602  
KLEINSASSER Suction Tube, outer diameter 2 mm, working length 23 cm

8591 A  
KLEINSASSER Forceps, straight, with 2 mm cupped jaws, with cleaning connector, working length 23 cm

8591 C  Same, curved to right

8591 D  Same, curved to left

8594 A  
KLEINSASSER Scissors, straight, with cleaning connector, working length 23 cm

8594 C  Same, curved to right

8594 D  Same, curved to left
Instruments for Large Lesions

LINDHOLM Distending Forceps, for atraumatic retraction of true vocal cords and false vocal cords, distal end with blunt curved blades, self-retaining, with ratchet, working length 24 cm

KLEINSASSER Grasping Forceps, without ratchet, serrated, straight, with cleaning connector, straight, working length 23 cm

Same, curved to right

Same, curved to left

Same, with triangular jaws, curved upwards to right

Same, curved upwards to left
Instruments for Large Lesions

8595 A  KLEINSASSER Knife, oval, straight, working length 23 cm

8595 C  Same, sickle-shaped, curved, pointed

8596 T  KLEINSASSER Knot Tier, working length 23 cm

8597  KLEINSASSER Handle, for use with 8595 A – 8596 T, 8655 A – K, 8693 A/B

8660 P  KLEINSASSER Needle Holder, straight, small model, for phonosurgery and endolaryngeal microsurgery, 1.8 x 3.5 mm jaws with cross serration, without ratchet, sheath reinforced from distal to proximal, with cleaning connector, working length 20 cm

8660 N  KLEINSASSER Needle Holder, delicate, straight, serrated jaws, size 1.8 x 3.5 mm, sheath conically reinforced from distal to proximal end, with ratchet, with cleaning connector, working length 23 cm
Instruments for Microlesions and Pediatric Phonosurgery

8654 BK

**Vocal Cord Retractor**, for atraumatic retraction of true vocal cords and false vocal cords in pediatrics, distal end with blunt curved blades, self-retaining, with ratchet and cleaning connector, working length 24 cm

8691 B

**Suction Tube**, handle with cut-off hole, tip with central opening, outer diameter 1.5 mm, working length 20 cm

8593 GM

**Miniature Grasping Forceps**, extra delicate, serrated, with triangular jaws, curved upwards to right, with cleaning connector, working length 23 cm

8593 HM

**Same**, curved upwards to left
Instruments for Microlesions and Pediatric Phonosurgery

8594 AM  KLEINSASSER Miniature Scissors, straight, with cleaning connector, working length 23 cm
8594 CM  Same, curved to right
8594 DM  Same, curved to left

8657 H  Universal Handle, forceps shape, with 2 handle rings, length 9 cm, for use with 3 mm instruments for phonosurgery and endolaryngeal microsurgery
8595 A – 8596 T, 8655 A – K and 8656 A – S

8656 B  Sickle Knife, straight cutting, delicate, 3 to 1 mm tapered shaft, total length 23 cm

8656 L  Elevator, slightly curved, blunt, delicate, 3 to 1 mm tapered shaft, total length 23 cm
8656 LS  Same, sharp tip
Instruments for Microlesions and Pediatric Phonosurgery

- **8681 A**: Micro Forceps, straight, with 1 mm cupped jaws, with cleaning connector, working length 20 cm
- **8681 C**: Same, curved to right
- **8681 D**: Same, curved to left
- **8683 D**: SHAPSHAY-PERETTI Micro Grasping Forceps, curved upwards to right, serrated, with triangular fenestrated jaws, with cleaning connector, working length 20 cm
- **8683 H**: Same, curved upwards to left
- **8683 D**: Same, curved to left, serrated, with cleaning connector, working length 20 cm
- **8683 C**: Same, curved to right
- **8684 A**: Micro Scissors, straight, with cleaning connector, working length 20 cm
- **8684 C**: Same, curved to right
- **8684 D**: Same, curved to left
Instruments for Phonomicrosurgery Under Local Anesthesia

**Indirect Laryngeal Forceps**, for biopsy, curved upwards, spoon diameter 4 mm, with cleaning connector, working length 17 cm

**PELTESON Cotton Applicator**, working length 27 cm

**FEHLAND-NAWKA Needle Holder**, with crosswise recess for holding the butterfly needle, for indirect injection into the larynx, with ratched, angled 90° to the right, with cleaning connector, working length 23 cm

**Same**, with ratchet, angled 90° to the left
HD Imaging with Operating Microscopes

Direct Adaption

With the operating microscope the surgeon always has a perfect view of the operating field. Assistants, OR nurses and students, however, often experience poor video presentations, especially if FULL HD visualization is not available. KARL STORZ offers a one-stop-shop solution to upgrade any surgical microscope with state-of-the-art FULL HD imaging technology. To achieve optimal results, all components in the video chain – from the camera system to the monitor – must be of the highest quality. The most straightforward and professional connection between camera and microscope is the so-called direct adaption. Here the H3-M COVIEW microscope camera and the corresponding QUINTUS® TV adaptor are directly connected to the microscope via the C-MOUNT connection.
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 106

IMAGE1 S H3-M COVIEW Three-Chip FULL HD Camera Head, 50/60 Hz, IMAGE1 S compatible, progressive scan, with C-MOUNT thread for coupling to microscopes, 2 freely programmable camera head buttons, with detachable camera head cable, length 900 cm, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

20200131

Keypad, for H3-M camera head, for convenient control of the most important H3-M camera functions, with PS/2 connector, cable length 1 m, alternative to a standard keyboard, for use with H3-M or H3-M COVIEW camera heads, only compatible with IMAGE1 HUB™ HD, not compatible with IMAGE1 S

Specifications:

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-M COVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product code</td>
<td>TH 106</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x ⅓” CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>45 x 50 x 60 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>240 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>C-MOUNT connection</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.9/1.4 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>C-MOUNT connection</td>
</tr>
<tr>
<td>Cable</td>
<td>detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>900 cm</td>
</tr>
</tbody>
</table>
HD Imaging with Operating Microscope

System Components

QUINTUS® – High-Performance TV Adaptor for Operating Microscopes

Unleash the full performance of your operating microscope from CARL ZEISS MEDITEC – with FULL HD imaging solutions from KARL STORZ.

The new QUINTUS® TV adaptor is the perfect interface between the operating microscope and the H3-M COVIEW FULL HD microscope camera head from KARL STORZ.

The innovative features of QUINTUS® are easy to use, making it one of the most flexible TV adaptors on the market.

Product Features:

- A rotating C-MOUNT connection at the QUINTUS® TV adaptor allows immediate adaption of the camera orientation during mounting.
- The focus control makes it possible to easily achieve parfocality (perfectly sharp camera and microscope images).
- The iris control provides convenient and optimal adjustment of the depth of field.
- Pan (X) function enables adjustment of the horizontal position of the camera image.
- Tilt (Y) function enables adjustment of the vertical position of the camera image. The pan and tilt functions help the surgeon to adjust the position of the camera image according to his individual needs.
- The QUINTUS® ZOOM model also features a variable focal length $f = 43 – 86$ mm. This allows the surgeon greater flexibility in choosing the exact zone required for documentation.

Focal length of the QUINTUS® TV adaptor:

The QUINTUS® TV adaptor is available in the fixed focal lengths $f = 45$ and $f = 55$ mm or as a zoom model with variable focal length $43 – 86$ mm. This provides an optimal FULL HD image in 16:9 in conjunction with the H3-M COVIEW HD microscope camera head from KARL STORZ.

Focal lengths: H3-M COVIEW camera image detail using a QUINTUS® TV adaptor with the fixed focal lengths of 45 and 55 mm.

Variable focal length: Adjustable H3-M COVIEW camera image detail using a QUINTUS® zoom adaptor with variable focal length of 43 – 86 mm.
HD Imaging with Operating Microscope

System Components

**QUINTUS® TV Adaptor** for operating microscopes from CARL ZEISS MEDITEC with fixed focal length

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>209230 45</td>
<td><strong>QUINTUS® Z 45 TV Adaptor</strong>, for CARL ZEISS MEDITEC operating microscopes, f = 45 mm, recommended for IMAGE 1 HD H3-M/H3-M COVIEW camera heads</td>
</tr>
<tr>
<td>209230 55</td>
<td><strong>QUINTUS® Z 55 TV Adaptor</strong>, for CARL ZEISS MEDITEC operating microscopes, f = 55 mm, recommended for IMAGE 1 HD H3-M/H3-M COVIEW, H3, H3-Z as well as IMAGE 1 S1 and S3 camera heads</td>
</tr>
</tbody>
</table>

**QUINTUS® Zoom TV Adaptor** for operating microscopes from CARL ZEISS MEDITEC with variable focal length

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>209230 00 Z</td>
<td><strong>QUINTUS® Zoom TV Adaptor</strong>, for CARL ZEISS MEDITEC operating microscopes, with variable focal length f = 43 – 86 mm, for use with all KARL STORZ cameras (SD and HD)</td>
</tr>
</tbody>
</table>

**Further accessories for operating microscopes from CARL ZEISS MEDITEC**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>209250 00</td>
<td><strong>Iris</strong>, for ZEISS Pentero®, iris as a necessary extension between the QUINTUS® TV adaptor and the operating microscope ZEISS Pentero®</td>
</tr>
<tr>
<td>301513</td>
<td><strong>Optical Beamsplitter 50/50</strong>, for use with ZEISS operating microscope or colposcope</td>
</tr>
</tbody>
</table>

**Note:** Optical beamsplitters for other operating microscopes (i.e. LEICA or Möller-Wedel) are available directly from the manufacturers.
HD Imaging with Operating Microscope
System Components

QUINTUS® TV Adaptor for operating microscopes from LEICA Microsystems with fixed focal length

209330 45 QUINTUS® L 45 TV Adaptor, for LEICA Microsystems operating microscopes, \( f = 45 \) mm, recommended for H3-M microscope camera head

209330 55 QUINTUS® L 55 TV Adaptor, for LEICA Microsystems operating microscopes, \( f = 55 \) mm, recommended for IMAGE 1 HD H3-M/H3-M COVIEW, H3, H3-Z as well as S1 and S3 camera heads

209330 45/209330 55

QUINTUS® TV Adaptor for operating microscopes from LEICA Microsystems with variable focal length

209330 00 Z QUINTUS® Zoom TV Adaptor, for Leica Microsystems operating microscopes, with variable focal length \( f = 43 – 86 \) mm, for use with all KARL STORZ cameras (SD and HD)

209330 00 Z

QUINTUS® TV Adaptor for operating microscopes from Möller-Wedel with fixed focal length

209530 45 QUINTUS® M 45 TV Adaptor, for Möller-Wedel operating microscopes, \( f = 45 \) mm, recommended for IMAGE 1 HD H3-M/H3-M COVIEW camera heads

209530 55 QUINTUS® M 55 TV Adaptor, for Möller-Wedel operating microscopes, \( f = 55 \) mm, recommended for IMAGE 1 HD H3-M/H3-M COVIEW, H3, H3-Z and S1, S3 camera heads

209530 45/209530 55

Note: Optical beamsplitters for other operating microscopes (i.e. LEICA or Möller-Wedel) are available directly from the manufacturers.
VITOM®
Visualization System for Open Surgery with Minimal Access
**VITOM®**  
**Visualization System for Open Surgery with Minimal Access**

The KARL STORZ VITOM® system represents a revolutionary and innovative way of displaying open surgery with minimal access in a high quality and ergonomic manner.

VITOM® is based on the renowned HOPKINS® rod lens system from KARL STORZ. With the help of a holding system, VITOM® is placed at a working distance of 25 – 75 cm above the surgical field. This gives the surgeon more room to work.

The small size of the VITOM® reduces space requirements in the OR to a minimum. Due to its slim and compact design, the surgical field is not obstructed and even long instruments can be used with ease. The VITOM® system provides great depth of field, optimal magnification, good contrast and excellent color reproduction, which are the ideal prerequisites for the best possible recording and playback in FULL HD quality.

The first-class enhanced imaging can be observed via a FULL HD monitor from a convenient distance by the surgeon, the assistant as well as the entire OR team.

The VITOM® system has proven to be an excellent alternative to OR illumination cameras, loupes or operating microscopes in various surgical disciplines.

The VITOM® is equipped with an integrated fiber optic light transmission that enables the connection of cold light sources used in endoscopy.

The system allows the further use of existing units. A FULL HD endoscope imaging solution from KARL STORZ can also be used with the VITOM® system.

The VITOM® system offers:
- Excellent FULL HD image quality
- Great depth of view
- Large working distance
- Ergonomic monitor work
- Compact design requiring minimal space in the OR
- Use of existing KARL STORZ FULL HD endoscopy system possible

Use of the VITOM® system in ENT surgery.

OR photographs courtesy of: Prof. Dr. Gero Strauss, Director of the International Reference and Development Center (IRDC), Leipzig, Germany.
VITOM®
System Overview

Exoscope

Camera System,
Monitor and Illumination

Mechanical
Holding System

Documentation System

Equipment Cart
VITOM®
System Components
Exoscope and Illumination – 2nd Generation VITOM® Telescopes
Length 11 cm

8100 AA

VITOM® Telescope 0° with Integrated Illuminator,
VITOM® HOPKINS® Straight Forward Telescope 0°,
working distance 25 – 75 cm, length 11 cm,
autoclavable, with fiber optic light transmission
incorporated and condensor lenses,
color code: green

Fiber Optic Light Cables 495 TIP or 495 NVC recommended

495 TIP
Fiber Optic Light Cable,
highly heat resistant,
diameter 4.8 mm, length 300 cm

495 NVC
Fiber Optic Light Cable,
with 90° deflection to the instrument,
very narrow radius of curvature,
diameter 4.8 mm, length 300 cm
**VITOM®**

System Components

**Exoscope and Illumination – 2nd Generation VITOM® Telescopes**

Length 11 cm

![VITOM® Telescope 90° with Integrated Illuminator](image)

**VITOM® Telescope 90° with Integrated Illuminator,**

VITOM® HOPKINS® telescope 90°, working distance 25 – 75 cm, length 11 cm, **autoclavable,**

with fiber optic light transmission incorporated and condensor lenses,

**color code:** blue

**Fiber Optic Light Cable 495 TIP recommended**

![Fiber Optic Light Cable](image)

**Fiber Optic Light Cable,**

highly heat resistant,

diameter 4.8 mm, length 300 cm
VITOM®
System Components

20 9180 20  VITOM® 25 Distance Rod, length 25 cm

39501 A2  Wire Tray for Cleaning, Sterilization and Storage
of two rigid endoscopes and one light guide cable, including holder for light post adaptors, silicone telescope holders and lid, external dimensions (w x d x h): 352 x 125 x 54 mm, for rigid endoscopes up to diameter 10 mm and working length 20 cm
## VITOM®
### Specifications

<table>
<thead>
<tr>
<th>Working distance:</th>
<th>25 – 75 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth of view at working distance of:</strong></td>
<td><strong>25 cm</strong></td>
</tr>
<tr>
<td><strong>Depth of view:</strong></td>
<td>approx. 3.5 cm</td>
</tr>
<tr>
<td><strong>Field of view at working distance of:</strong></td>
<td><strong>25 cm</strong></td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 1x</strong></td>
<td>5 cm</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 2x</strong></td>
<td>3.5 cm</td>
</tr>
<tr>
<td><strong>Reproduction scale at working distance of:</strong></td>
<td><strong>25 cm</strong></td>
</tr>
<tr>
<td><strong>26&quot; Monitor:</strong></td>
<td>approx. 8x</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 1x</strong></td>
<td>approx. 16x</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 2x</strong></td>
<td>approx. 28x</td>
</tr>
<tr>
<td><strong>42&quot; Monitor:</strong></td>
<td>approx. 14x</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 1x</strong></td>
<td>approx. 28x</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 2x</strong></td>
<td>approx. 34x</td>
</tr>
<tr>
<td><strong>52&quot; Monitor:</strong></td>
<td>approx. 17x</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 1x</strong></td>
<td>approx. 34x</td>
</tr>
<tr>
<td><strong>H3-Z camera zoom 2x</strong></td>
<td>approx. 42x</td>
</tr>
</tbody>
</table>

Technical specifications are subject to change.
VITOM®

System Components

Cold Light Fountain XENON 300 SCB

Special Features:
- Extremely high light intensity due to 300 Watt Xenon lamp
- Built-in antifog pump
- With integrated KARL STORZ Communication Bus (KARL STORZ-SCB)

201331 01-1 Cold Light Fountain XENON 300 SCB

power supply 100 – 125/220 – 240 VAC, 50/60 Hz
including:
Mains Cord
Silicone Tubing Set, length 250 cm
SCB Connecting Cable, length 100 cm

Specifications:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp type</td>
<td>XENON 15 V, 300 Watt</td>
</tr>
<tr>
<td>Color temperature</td>
<td>6000 K</td>
</tr>
<tr>
<td>Light outlets</td>
<td>1</td>
</tr>
<tr>
<td>Light intensity adjustment</td>
<td>continuously adjustable via a membrane keyboard or KARL STORZ Communication Bus Signal</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 165 x 335 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>7.96 kg</td>
</tr>
<tr>
<td>Certified to</td>
<td>IEC 601-1 and UL 544, protection class 1/CF</td>
</tr>
</tbody>
</table>
**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**

**Live menu**

**Intelligent icons**

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

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

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 200EN*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD video outputs</td>
<td>- 2x DVI-D</td>
</tr>
<tr>
<td></td>
<td>- 1x 3G-SDI</td>
</tr>
<tr>
<td>Format signal outputs</td>
<td>1920 x 1080p, 50/60 Hz</td>
</tr>
<tr>
<td>LINK video inputs</td>
<td>3x</td>
</tr>
<tr>
<td>USB interface</td>
<td>4x USB, (2x front, 2x rear)</td>
</tr>
<tr>
<td>SCB interface</td>
<td>2x 6-pin mini-DIN</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2.1 kg</td>
</tr>
</tbody>
</table>

### 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:

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 300 (H3-Link)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera System</td>
<td>TH 100, TH 101, TH 102, TH 103, TH 104, TH 106 (fully compatible with IMAGE1 S)</td>
</tr>
<tr>
<td></td>
<td>22220055-3, 22220056-3, 22220053-3, 22220060-3, 22220061-3, 22220054-3, 22220085-3 (compatible without IMAGE1 S technologies CLARA, CHROMA, SPECTRA*)</td>
</tr>
<tr>
<td>LINK video outputs</td>
<td>1x</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
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<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

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

**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

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**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 \( f = 15–31 \text{ mm} \) (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

### Specifications:

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product no.</td>
<td>TH 100</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x ( \frac{1}{3} ) CCD chip</td>
</tr>
<tr>
<td>Dimensions ( w \times h \times d )</td>
<td>39 x 49 x 114 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>270 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, ( f = 15–31 \text{ mm} ) (2x)</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>

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**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 \( f = 15–31 \text{ mm} \) (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

### Specifications:

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-ZA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product no.</td>
<td>TH 104</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x ( \frac{1}{3} ) CCD chip</td>
</tr>
<tr>
<td>Dimensions ( w \times h \times d )</td>
<td>39 x 49 x 100 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>299 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, ( f = 15–31 \text{ mm} ) (2x)</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>
Monitors

9619 NB

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

9826 NB

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&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>9619 NB</td>
<td>9826 NB</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&quot;</th>
<th>26&quot;</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>
VITOM® New

System Components

Mechanical Holding System

28272 HC  Articulated Stand, L-shaped, long, reinforced version, only, especially large swivel range, with one mechanical central clamp for all five joint functions, height 48 cm, swivel range 66 cm, with quick release coupling KSLOCK (female)

28172 HR  Rotation Socket, to clamp to the operating table, with one mounted Butterfly Nut 28172 HRS, for European and US standard rails, with lateral clamp for height and angle adjustment of the articulated stand

28172 HM  Extension Rod, 50 cm, with lateral clamp for height adjustment of the articulated stand, for use with articulated stands 28272 HA, 28272 HB or 28272 HC and socket 28172 HK or 28172 HR

28272 UGN  Clamping Jaw, metal, clamping range 16.5 up to 23 mm, with quick release coupling KSLOCK (male), for use with all square-headed KARL STORZ HOPKINS® telescopes

28272 UGK  Clamping Jaw, with ball joint, large, clamping range 16.5 to 23 mm, with quick release coupling KSLOCK (male), for use with all square-headed KARL STORZ HOPKINS® telescopes

28272 CN  Clamping Cylinder, folding, for flexible mounting of 10 mm telescopes on the telescope sheath, autoclavable. The clamping cylinder allows vertical movement and rotation of the telescope.
VITOM® NEW
System Components

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.
VITOM® NEW
System Components

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.
VITOM® NEW

System Components

Documentation System

20 0905 19 19” KARL STORZ Touch Screen, 24V, wall mounting. RS 232, VGA, resolution max. 1280 x 1024 (SXGA mode), including RS 232 cable, SVGA cable, mains cord and external power supply 24 VDC, power supply 100 – 240 VAC, 50/60 Hz

041265-20* Sterile Cover, for 19” KARL STORZ touch screen

29005 MSK Monitor Holding Arm, height and side adjustable, tilting, can be mounted either on the left or on the right side, swivel range 190°, reach 300 mm, loading capacity max. 15 kg, with monitor holder VESA 75/100, for Equipment Carts 29005 xx

Equipment Cart

UG 220 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
**Recommended Accessories for Equipment Cart**

- **Monitor Swivel Arm**, UG 540
  - 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

- **Isolation Transformer**, UG 310
  - 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**, UG 410
  - 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**, UG 510
  - 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
Notes:
Notes: