ENHANCED CONTACT ENDOSCOPY (ECE) IN HEAD AND NECK SURGERY

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## Background and Rationale

The diagnosis of inflammatory, premalignant and malignant lesions of the mucosa of the *Upper Aero-Digestive Tract (UADT)* starts with the direct visual evaluation – either with or without magnification – of the macroscopic appearance of a lesion, commonly known as leukoplakia, erythroplakia or leuko-erythroplakia, and its surrounding mucosa.

In the clinical diagnosis of lesions of the UADT, *white light (WL)* endoscopic imaging is used in the first instance, however incipient epithelial alterations or sub-epithelial changes cannot be identified with this modality, leaving the endoscopist unable to undertake a more detailed analysis of the area of interest, which is mandatory to establish a reliable diagnosis differentiating benign neoplasms from their malignant counterparts. The awareness of these limitations has been the main impulse to keep focused on advanced imaging techniques for endoscopic-assisted management of diseases of the UADT. Research and development efforts have been geared toward enhanced imaging techniques allowing macroscopic and even subtle microscopic changes pathognomonic of pre-cancerous and cancerous lesions to be visualized at an early stage. The concept of *biologic endoscopy* is based on various components which are taken from the standard armamentarium of the otorhinolaryngologist – head and neck surgeon and it is complemented by a variety of techniques, some of which requiring more sophisticated systems.

### 1.1 Autofluorescence Imaging Endoscopy (AIE)

Among the most widely accepted enhanced imaging modalities, autofluorescence uses the natural property of specific endogenous tissue components (fluorophores) to emit fluorescence following exposure to light or other *electromagnetic radiation (EMR)*. Unlike the normal healthy mucosa – which appears in bright green when subjected to excitation light delivered by a dedicated autofluorescence system – neoplastic mucosa assumes a red-violet appearance; in healthy tissues, riboflavins (also known as Vitamin B2) are in an oxidized state and show strong fluorescence emission at wavelengths of approximately 520 nm, resulting in bright green fluorescence. Conversely, in the presence of dysplasia and/or malignant lesions, owing to the reduced concentration level of riboflavins, there is a marked decrease or even absence of green fluorescence, and the lesion appears in a blue/dark violet color. Even though AIE has gained in acceptance for early detection of mucosal alterations suggestive of malignancy, a closer look needs to be taken at the limitations inherent to the modality:

- Granulation tissue and telangiectasia lead to a similar reduction in bright-green fluorescence on account of the absorptive properties of the heme molecule, which makes these findings indistinguishable from autofluorescence triggered by a neoplastic growth.
- Scar tissue, necrosis, and inflammation can also alter mucosal autofluorescence to a variable degree thereby reducing the accuracy of the method.

Although any additional endoscopic examination can provide further useful information, AIE is valuable in that it enables an improved intraoperative analysis of surgical margins.

### 1.2 Conventional Chromoendoscopy

The main clinical application of conventional chromoendoscopy in the UADT is to highlight tissue characteristics particularly for the purpose of detecting suspicious findings in the upper esophagus and larynx. Chromoendoscopy uses contrast dyes to enhance the visual characteristics of the mucosa and to highlight dysplastic and malignant alterations otherwise not amenable to detection by WL endoscopy. The most commonly used dyes (e.g., Lugol's iodine solution, methylene blue) are sprayed with a catheter or applied directly through the working channel of the scope onto the mucosa where they are absorbed and passed through selectively permeable epithelial membranes, while reactive stains (e.g., Congo red and phenol red) undergo chemical reactions with specific cellular components, resulting in a change of color detectable by the endoscopist. To this day, however, the method has been rarely used in the UADT.

### 1.3 Contact Endoscopy (CE)

Cytological characteristics of the mucosa of the UADT have been thoroughly investigated by means of *contact endoscopy (CE)*. The method was originally described in the early 1980s for screening and diagnosis of cervical and uterine cancer. CE allows for both in-vivo and in-situ observations of pathology which appear in the most superficial layer of the epithelium as a consequence of dynamic migration of deeper cells. In the field of gynecology, CE was performed with a dedicated hysteroscope (HAMOU Micro Contact Hysteroscope with HOPKINS® rod-lens system (25165 B) offering 60x and 120x magnification (KARL STORZ Tuttingen, Germany).

In the area of head and neck oncology, CE was first described in the 1990s as a diagnostic tool for evaluation of various types of epithelial tumors. The basic technique of CE involves staining of the superficial cells of the mucosa with 1% methylene blue, followed by a detailed examination of the suspected areas.

The penetration depth of the absorbed excitation light does not go beyond the pathologically altered epithelium and, as a result, epithelial hyperkeratosis may obscure neoplastic changes within the basal mucosal layer.
under magnification using the ANDREA-DIAS Contact Micro Laryngoscope with HOPKINS rod-lens system (diameter 5.5 mm, length 23 cm, 0° straight-forward view, 8715 A). In order to obtain images of cytological details, the distal tip of the laryngoscope must be in close contact with the mucosal surface. Expansion of squamous epithelium from the vocal fold edges to the areas of columnar epithelium can be clearly visualized by CE. Hyperkeratosis or leukoplakia are clearly observed on CE, and the superficial dysplasia noticeable concomitant with these findings is generally characterized by an impaired nuclear-cytoplasmic ratio, nuclear hyperchromasia and variation in the number and appearance of the nucleoli.\(^{10}\)

Finally, in-situ and invasive carcinoma are characterized by heterogeneity of the cell population. Classically, CE does only allow to examine the superficial cellular architecture of the epithelium and it is not feasible to assess cellular anomalies occurring at the level of the basal layer of the epithelium. These inherent limitations are due to the poor penetration depth of methylene blue which only stains the superficial layers, and secondly, due to optical artifacts commonly encountered at high magnifications and noticeable glare which is caused by light reflection on superficial cell layers outside the scope’s focus (the focal distance of the endoscope is 80 µm at 60x magnification and 30 µm at 150x and/or 60x magnification). The use of methylene blue can also modify the clinical appearance of the lesion and surrounding mucosa particularly when located in the supraglottis where the dye predominantly stains minor salivary glands. As a result of these limitations, the use of CE, per se, has been abandoned over the years, the use of neoangiogenesis has emerged as a distinct convincing in nature.

During neoplastic angiogenesis, tumor cells induce the abnormal development of intrapapillary capillary loops (IPCL), rapidly growing around the loops to form microscopic cylinders, with a radius usually not exceeding the oxygen diffusion distance of 150–200 µm.\(^{9}\) Considering that angiogenic factors are continuously released by neoplastic cells which stimulate capillary growth over distances of 2–5 mm, the microvascular network of cancerous lesions is growing rapidly, thereby assuming a dilated, elongated and distorted appearance. In a nutshell, the higher the degree of dysplasia (and thus the neoangiogenic stimulus), the greater the degree of architectural vascular chaos.\(^{13}\)

A major milestone toward the goal of higher image definition both in conventional WL and in videendoscopic systems using image enhancement technology was reached with the marketing of high-definition television (HDTV) camera systems, providing at least 1080 lines of resolution, which is far superior to standard definition systems. The ongoing progress in this major technological sector has lead to a variety of 3D endoscope systems and has recently culminated with the introduction of Ultra HD systems providing 4K standard with a horizontal screen display resolution of approximately 4,000 pixels.

Currently, imaging technologies that provide detailed contrast enhancement of the mucosal surface and blood vessels are widely used in many medical specialties. The major focus of current research and development in the field of endoscopic imaging technologies is geared toward the advancement of image-enhanced endoscopy (IEE) systems (i-SCAN, NBI and IMAGE1 S™ ) which allow for detection and enhanced characterization of lesions in terms of microvascular and endocytoscopic abnormalities such as dilation, twisting and caliber irregularities of the capillary loops at the level of a neoplasm.\(^{14}\)

i-SCAN is a software-based, digital, post-processing image enhancement technology from Pentax Medical which intensifies the contrast of endoscopic images and thus enhances the appearance of the mucosal surface and of blood vessels.\(^{15}\) i-SCAN enables the user to perform real-time virtual chromoendoscopy for detailed representation of mucosal and vascular patterns. It offers three different enhancement options to highlight specific anatomical features (surface enhancement, contrast enhancement, and tone enhancement). The scope of enhanced visualization modes is suited to facilitate early detection, demarcation and characterization of various lesions.\(^{16}\) i-SCAN has been mostly used in the diagnostic assessment of the gastrointestinal tract.

Precancerous and cancerous lesions of the UADT have been macroscopically examined, at usual endoscopic distance allowed by flexible scopes, with Narrow Band Imaging (NBI) (Olympus Medical Co., Tokyo, Japan).\(^{17,18}\) NBI was initially developed as a diagnostic tool used in the gastrointestinal tract, but it is now also used to inspect other areas including the UADT and urinary tract. The NBI filter, incorporated in the light source, selects the blue and green light (wavelengths of 415 and 540 nm, respectively), cor-

- New capillaries arise from small arterioles and arterial capillaries (metarterioles), the latter forming direct communications between arterioles and venules which lack an outer layer of smooth muscle cells.\(^{12}\)
- In the presence of an angiogenic stimulus, endothelial cells within a venule begin to degrade the vascular basement membrane and protrude through the wall of the vessel.
- The locomotion of endothelial cells toward the angiogenic stimulus is associated with their linear alignment as they form a capillary sprout.\(^{12}\)
- Endothelial proliferation takes place within the sprout but not usually at its tip.
- The tip of one sprout joins with another to form a capillary loop through which blood begins to flow.
- New basement membrane is formed and microvascular pericytes are incorporated into it.

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Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery
responding to the peaks of hemoglobin absorption. These wavelengths can penetrate the superficial mucosal layers, emphasizing the underlying capillary network without scattering in the deeper layers, increasing tissue contrast and enhancing superficial capillaries and neoangiogenesis in abnormal mucosa. Ni et al.\textsuperscript{14} and Takano et al.\textsuperscript{19} correlated the macroscopically superficial ‘spots’ usually visualized, to vascular anomalies and proposed two different classifications based on the superficial vascular patterns respectively in laryngeal and oral cavity lesions enhanced at NBI.

1.4. IMAGE Technology

IMAGE1 S\textsuperscript{TM} (KARL STORZ Tuttlingen, Germany) is a versatile digital full HD video system, providing specific color rendering of the acquired broad visible spectrum within the HD-camera system. Since spectral separation is obtained within the camera system and is amplified by adapted color processing algorithms, the IMAGE1 S\textsuperscript{TM} system does not require a dedicated narrow band light source and operates with a standard light source with the whole spectral light information. Therefore, IMAGE1 S\textsuperscript{TM} enhances the appearance of the mucosal surface structures and subepithelial vasculature by selected wavelengths of light providing, beside the standard mode at WL, five different predefined spectral ranges (CLARA, CLARA+CHROMA, CHROMA, SPECTRA A*, SPECTRA B*) as shown in Figs. 1.1–1.4.

\textsuperscript{*} SPECTRA A/B: Not for sale in the U.S.A.

**Fig. 1.1** The visible portion of the electromagnetic spectrum ranges roughly from 400 to 700 nm.

**Fig. 1.2** The highlighted wavelength range of the measured reflectance spectrum in the graph shows the scope of the filter integrated in the IMAGE1 S\textsuperscript{TM} system.

**Fig. 1.3** Still images of a standardized color sample card captured with the IMAGE1 S\textsuperscript{TM} system in WL mode (a), in SPECTRA A mode (b), and in SPECTRA B mode (c).

**Fig. 1.4** Macroscopic views of chronic laryngitis with pseudocysts. The images were captured with IMAGE1 S\textsuperscript{TM} using WL mode (a) and the enhancement modes CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).
Advanced application of image-enhanced endoscopy can facilitate the diagnosis of very early precancer and cancer, which is key to a minimally invasive endoscopic resection. Furthermore, it allows to advance the concept of ‘optical biopsy’, the objective of which is to employ a non-invasive, real-time diagnostic approach for a more accurate early diagnosis of precancerous and cancerous lesions of the UADT. IEE offers the prospect of becoming a viable option to prevent wrong-site biopsies, unnecessary biopsies, overtreatment or incomplete surgical resections. Enhanced contact endoscopy is based on the dynamic fusion of conventional IEE with CE – but without the need for vital staining – and thus combines the advantages of both modalities. In the authors’ group, ECE is used for clinical assessment of normal, inflammatory, precancerous and cancerous lesions of the UADT.

When IEE is performed using standard HOPKINS® rod-lens scopes in conjunction with an HD video system, it is not uncommon that minor vascularity of preneoplastic areas or even of cancer appears as ‘endoscopic mucosal spots’ which sometimes cannot be clinically interpreted unambiguously. Therefore, a certain degree of experience is required to avoid false-positive and false-negative findings. Furthermore, hyperkeratosis can hide deeper epithelial and vascular alterations. Difficulties in the assessment of specific enhanced areas can be reduced by using the magnified view of the contact endoscope to scrutinize the vascularity. In this way, the microvascular architecture can be examined in detail while avoiding the staining. The technique was originally defined by our group as Enhanced Contact Endoscopy (ECE) using the IMAGE1S™ system in parallel with NBI. The latter was abandoned because of emerging limitations related to deficiencies in obtaining images of paramount accuracy.

Enhanced contact endoscopy is based on the dynamic fusion of conventional IEE with CE – but without the need for vital staining – and thus combines the advantages of both modalities. In the authors’ group, ECE is used for clinical assessment of normal, inflammatory, precancerous and cancerous lesions of the UADT.

A precise and simple vascular classification scheme which is based on accurate images obtained by ECE has been proposed by our group for the larynx (see Section 2, Table 2.1).

### Classification of Vascular Patterns on Enhanced Contact Endoscopy

<table>
<thead>
<tr>
<th>Vascular Pattern</th>
<th>Diagnosis</th>
<th>Description of Findings on ECE</th>
<th>Schematic Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 0</td>
<td>Normal mucosa.</td>
<td>Tapering, regular-shaped subepithelial vessels connecting with a thicker and deeper arborescent vascular network running parallel.</td>
<td><img src="image1" alt="Type 0 Diagram" /></td>
</tr>
<tr>
<td>Type I</td>
<td>Inflammation.</td>
<td>The subepithelial vessels are increased in number and caliber, exhibiting an irregular course and sporadic intersections.</td>
<td><img src="image2" alt="Type I Diagram" /></td>
</tr>
</tbody>
</table>

Table 2.1 Classification scheme of vascular patterns noticeable under enhanced contact endoscopy (ECE) (continued on page 11).
## Classification of Vascular Patterns on Enhanced Contact Endoscopy

### 2.1 Vascular Patterns

#### 2.1.1 Normal Pattern

When evaluated with ECE, the normal mucosa displays a mostly parallel arrangement of regular and thin chorionic vessels, which are limited in number and regular in caliber (Fig. 2.1).

<table>
<thead>
<tr>
<th>Vascular Pattern</th>
<th>Diagnosis</th>
<th>Description of Findings on ECE</th>
<th>Schematic Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II</td>
<td>Hyperplasia.</td>
<td><strong>a)</strong> The capillary loops are seen to rise toward the surface. In this phase, the capillary loops commonly are still very thin and short. They arise from the underlying inflammatory vasculature, with a scattered distribution.</td>
<td><img src="image1" alt="Schematic diagram of a normal vascular pattern" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>b)</strong> The deeper inflammatory vascular network is not visible — only the elongated capillary loops are readily identified. In case of vegetating keratosis, the deeper inflammatory vascular network is often not visible, and the elongated capillary loops are difficult to be identified. A special type of ‘bobby pin’-shaped loops is seen at sites of laryngeal papillomatosis, where the typical papillae encase the ‘bobby pin’-shaped loops inside the papilloma.</td>
<td><img src="image2" alt="Schematic diagram of a normal vascular pattern" /></td>
</tr>
<tr>
<td>Type III</td>
<td>Mild-to-moderate dysplasia.</td>
<td>Vascular changes become progressively more consistent. The elongated vessels of smaller caliber appear with typical ‘bobby pin’ shape, but some arborescence appears at the end of the capillary loops.</td>
<td><img src="image3" alt="Schematic diagram of a normal vascular pattern" /></td>
</tr>
<tr>
<td>Type IV</td>
<td>High-grade dysplasia / carcinoma in situ / invasive carcinoma.</td>
<td>The irregular vascularization of the chorion becomes more evident, with capillary loops appearing significantly dilated. There is a high degree of variation in shape, caliber and microvascular architecture, such as corkscrew vessels or tree-like patterns.</td>
<td><img src="image4" alt="Schematic diagram of a normal vascular pattern" /></td>
</tr>
</tbody>
</table>

**Table 2.1** Classification scheme of vascular patterns noticeable under enhanced contact endoscopy (ECE).

*Fig. 2.1* ECE view taken at 60x magnification with IMAGE1 S™ mode SPECTRA B (a). Schematic diagram of a normal vascular pattern (b).
2.1.2 Pattern I
When the mucosa of the UADT is altered by inflammatory changes, submucosal vessels appear increased in number and size, with an irregular course and abrupt changes in direction, but they do not develop pronounced intrapapillary capillary loops (Fig. 2.2).

![Fig. 2.2](image)

2.1.3 Pattern II
After prolonged exposure to an irritative stimulus, hyperplasia and mild dysplasia can show similar neoangiogenesis, appearing as clearly visible microvascular capillary loops, but with some minor changes between the two. The capillary loops are visible running toward the surface. In this phase, capillary loops commonly are still very thin and short, arising from the underlying inflammatory vasculature, with a scattered distribution (vascular pattern type IIa). Normally, the deep vascular network escapes vision if there is pronounced hyperplasia (vascular pattern type IIb) (Fig. 2.3).

![Fig. 2.3](image)
The chorionic vascular architecture of the hyperplasia shows the typical ‘bobby pin’-shaped capillary loops which are characteristic for patterns type IIa and IIb (see Fig. 2.3). The typical microvascular proliferation of the capillary loops identified on ECE is confirmed by histological analysis using CD-31 immunohistochemical staining (Fig. 2.4).

2.1.4 Pattern III

We found out that there is a high level of correlation between mild-to-moderate dysplasia and vascular pattern type III, where the IPCLs become more irregular and less numerous, with elongated small vessels showing the typical ‘bobby pin’ shape, but with some arborescence appearing at the end of the capillary loops (Fig. 2.5).

Since in the majority of cases there is more than one abnormality (extension, dilation, weaving and variation in the shape of vessels often coexist), the minimal architectural changes of dysplasia sometimes mimick the architecture of hyperplasia – commonly associated with inflammation – which can make it difficult to establish a differential diagnosis between hyperplasia versus mild-to-moderate dysplasia (Fig. 2.6).
2.1.5 Pattern IV
Vascular changes become an even more consistent trait, ranging from the typical ‘bobby pin’ architecture of hyperplasia to mild dysplasia, passing through corkscrew shape of high-grade dysplasia until the completely subverted vascular architecture of squamous cell carcinoma becomes clearly visible (Fig. 2.7).

![Fig. 2.7](image)

Fig. 2.7 ECE images with vital staining, taken at 60x magnification with IMAGE1 S™ modes SPECTRA A (a) and SPECTRA B (b) showing a vascular pattern IV. (b). Schematic diagram of a vascular pattern IV (c).

3 Core Components and Methodology of Enhanced Contact Endoscopy (ECE)

The core component of the ECE system used by the authors is the modular IMAGE1 S™ platform (KARL STORZ Tuttlingen, Germany) which offers multiple video input / output functions. On a routine basis, the HD video camera system is coupled to a Full-HD widescreen monitor (26” or 32”).

Apart from standard WL applications, the digital image processing module of IMAGE1 S™ can be operated in various enhancement modes to suit individual needs and circumstances. On the push of a button the user can choose between CLARA, CLARA+CHROMA, CHROMA, SPECTRA A and SPECTRA B. The special features of these modes will be explained in greater detail later in this chapter.

Freely programmable buttons on the camera head not only allow the user to select between various enhancement options of the IMAGE1 S™ platform, but also enable control of peripheral devices such as the Xenon cold light source. For macroscopic diagnostic assessment of preoperative and/or intraoperative findings, the IMAGE1 S™ link module is coupled to a flexible and/or rigid endoscope which can be operated at a short distance both under WL and IEE. The full range of visualization and enhancement options of IMAGE1 S™ can be used to identify pathologically altered areas of the UADT with different vascular anomalies (Fig. 3.1).

The mucosa identified as ‘suspicious’ is more precisely investigated by the clinician with the 0° contact micro-laryngoscope (KARL STORZ item no. 8715 AA, diameter 5.5 mm, length 23 cm) at 60x and, if needed, at 150x magnification. The contact micro-laryngoscope is gently placed in direct contact with the mucosal surface and moved slowly over the lesion and surrounding mucosa (Fig. 3.2).
Video images are captured by the camera and digitally stored as stills or video sequences. This function can be used over the entire scope of modalities offered by the IMAGE1 S™ platform. Finally, the vascular patterns are classified based on the features described in Table 2.1.

The clinical in-vivo assessment of ECE findings obtained at 60x or 150x magnification is the standard method preferred by the authors to scrutinize vascular patterns and to delineate the margins between normal and pathologically altered mucosa. In this way, ECE can be used to improve the accuracy of preoperative and intraoperative staging of a suspicious lesion (by defining the extent of a detected neoplasm and looking for coexisting lesions). What is more, this approach has proven helpful to assist the operating surgeon in achieving tumor-free margins during resection.

During ECE, the image enhancement modes IMAGE1 S™ platform can be used in conjunction with each other, most commonly employing CLARA and CLARA+CHROMA as well as CHROMA SPECTRA A and B in an alternating fashion. The following are the various features of the image enhancement modes offered by the IMAGE1 S™ platform.

- **CLARA** provides a more homogeneous distribution of optical density values in that it dynamically brightens up dark areas while allowing a more distinct visualization in the depth of the mucosal layer, which is particularly useful at the level of larynx and trachea.
- **CHROMA** uses a sophisticated software algorithm to enhance image contrast in areas where differentiation of details is difficult.
- Using CLARA and CHROMA in conjunction with each other brightens up dark aspects of the image while at the same time improving contrast. This is of great value when a more detailed examination of the vasculature is needed. The combined use of CLARA+CHROMA is among the enhancement modes most frequently used in biologic endoscopy and ECE.
- The IMAGE1 S™ modes SPECTRA A* and B* selectively enhance the blue-light wavelength range, which offers a more distinct visualization of blood vessels and facilitates discrimination between microvasculature and surrounding tissue.

**Fig. 3.3** Macroscopic views of a left hypopharyngeal lesion captured with IMAGE1 S™ modes CLARA+CHROMA (a) and SPECTRA A (b).

Switching between CLARA + CHROMA mode and SPECTRA A mode on the one hand, as well as between SPECTRA A and SPECTRA B mode on the other, facilitates a more precise assessment of lesions which can be examined with / without magnification (Figs. 3.3, 3.4).

**Fig. 3.4** Macroscopic views (same site as in Fig. 3.3) captured with IMAGE1 S™ modes SPECTRA A (a) and SPECTRA B (b). A close-up view reveals the more extensive superficial spread of the lesion (arrows).

* SPECTRA A/B: Not for sale in the U.S.A.
Prospective Cohort Study

4.1 Methods

A single-blinded prospective cohort study was performed on 145 patients with suspicious lesions of the UADT from September 2013 to September 2016 (Chart 4.1).

- 34 patients with lesions of the oral cavity;
- 13 patients with lesions of the oropharynx;
- 13 patients with lesions of the hypopharynx;
- 85 patients with lesions of the larynx.

Table 4.1 Division into patient groups according to anatomy.

In the entire study, a total of 262 surgical specimens were examined by histopathological analysis. Clinical findings were determined on the basis of vascular patterns identified on macroscopic IEE and ECE. Ultimately, the clinical findings which had been established with the above modalities were correlated with the definitive histological diagnosis.

At total of 25 healthy volunteers were selected to form the control group of the study. Each individual participating in the study was evaluated with a contact endoscope (KARL STORZ Tuttlingen, Germany) using both modalities – standard IEE and ECE – at the level of the oral cavity and pharynx.

Chart 4.1 Overview of a single-blinded prospective cohort study performed on 145 patients with suspicious lesions of the UADT (September 2013 – September 2016).
4.2 Results

4.2.1 Oral Cavity

Thirty-four patients (19 males, 15 females, mean age of 57.9 years, range of 27–88 years) were affected by erythroplakia, leukoplakia or leuko-erythroplakia of the oral cavity. At histology, 8 specimens showed normal mucosa, 7 inflammation, 14 hyperplasia, 9 mild-to-moderate dysplasia, and 18 squamous cell carcinoma.

The vascular patterns determined according to the ECE scheme matched with the histological diagnosis in 53 out of 56 specimens (3 wrong interpretations), with an overall accuracy rate of 94.6% (Chart 4.2).

![Chart 4.2](Image)

Chart 4.2 Detailed analysis of the specimens obtained from the oral cavity.

4.2.2 Oropharynx

Thirteen patients (9 males, 4 females, mean age of 53.1 years, range of 38–67 years) were affected by erythroplakia, leukoplakia or leuko-erythroplakia of the oropharynx.

At histology, 5 specimens showed inflammation, 6 hyperplasia, 7 mild-to-moderate dysplasia, and 5 squamous cell carcinoma.

The vascular patterns determined according to the ECE scheme matched with the histological diagnosis in 20 out of 23 specimens (3 wrong interpretations), with an overall accuracy rate of 87% (Chart 4.3).

![Chart 4.3](Image)

Chart 4.3 Detailed analysis of the specimens obtained from the oropharynx.
4.2.3 Hypopharynx

Thirteen patients (13 males, no females, mean age of 59.3 years, range of 56–65 years) were affected by erythroplakia, leukoplakia or leuko-erythroplakia of the hypopharynx.

At histology, 1 specimen showed normal mucosa, 6 inflammation, 1 mild-to-moderate dysplasia, and 14 squamous cell carcinoma.

The vascular patterns determined according to the ECE scheme matched with the histological diagnosis in 21 out of 22 specimens (1 wrong interpretation), with an overall accuracy rate of 95.5% (Chart 4.4).

![Chart 4.4](image)

**Chart 4.4** Detailed analysis of the specimens obtained from the hypopharynx.

4.2.4 Larynx

Eighty-five patients (70 males, 15 females, mean age of 65.6 years, range of 27–85 years) were affected by erythroplakia, leukoplakia or leuko-erythroplakia of the larynx.

At histology, 11 specimens showed normal mucosa, 14 inflammation, 44 hyperplasia, 33 mild-to-moderate dysplasia, and 59 squamous cell carcinoma.

The vascular patterns determined according to the ECE scheme matched with the histological diagnosis in 149 out of 161 specimens (12 wrong interpretations), with an overall accuracy rate of 92.5% (Chart 4.5).

![Chart 4.5](image)

**Chart 4.5** Detailed analysis of the specimens obtained from the larynx.

4.3 Summary

ECE showed an overall accuracy of 92.7% in the assessment of the precise degree of hyperplastic, dysplastic, and cancer of the mucosa of the UADT.

Sensibility, specificity, positive predictive value and negative predictive value in the differential diagnosis between non-malignant (normal mucosa, inflammation and hyperplasia) versus premalignant/malignant (mild-to-moderate dysplasia and squamous cell carcinoma) lesions were 95.9%, 91.4%, 93.3%, and 94.6% respectively.

In 26 patients, ECE allowed a more precise diagnosis compared to IEE alone, and allowed the diagnosis of 14 additional lesions not visible at WL and IEE without CE. In the group of patients submitted to excisional biopsy for squamous cell carcinoma (47 patients: 9 in the oral cavity, 1 in the oropharynx, 2 in hypopharynx and 35 in the larynx), the rate of positive tumor margins at histology was 8.5% (n = 4).
5 Enhanced Contact Endoscopy in the Upper Aerodigestive Tract

5.1 Oral Cavity

The oral mucosa is classified on the basis of structural and functional differences into masticatory mucosa, lining mucosa and specialized mucosa.

The specialized mucosa is characterized by the presence of the lingual papillae covering the dorsum of the tongue and occupying approximately 15% of the oral cavity. The masticatory mucosa covers those areas of the oral cavity such as the hard palate and gingiva, exposed to compressive and shear forces and to abrasion during chewing (25% of the oral cavity surface). The epithelium of the masticatory mucosa is moderate thicker compared to other regions, and it is frequently orthokeratinized. The lining mucosa covers the underside of the tongue, floor of mouth, inside of lips and cheeks, alveolar processes and soft palate, occupying approximately 60% of the oral cavity. The epithelium of the lining mucosa is thinner in some area such as the floor of mouth (100 µm), and thicker, sometimes exceeding 500 µm, in the cheek. The specialized mucosa of the dorsal surface of the tongue is unlike that found elsewhere in the oral cavity because it is also a highly extensible lining, and presents different types of lingual papillae and, posteriorly, lymphoid tissue.

The mucosa and submucosal chorion of the oral cavity can be altered by a wide range of common disorders, such as periodontitis, lichen planus or chronic local inflammation. In those conditions, the epithelial thickness of the oral cavity (usually calculated from the epithelial surface to the basal membrane) can be thicker. However, the papillae of the lamina propria (and their intra-papillary capillary loops) usually reach a more superficial layer, with the length of the papillae being directly proportional to the thickness of the epithelium.24 As a consequence, the actual distance between the surface of the mucosa and the papillary apex allows the precise assessment of the mucosa of the oral cavity by the analysis with IEE and ECE in the majority of the cases.

A research conducted by the authors demonstrated physiological changes of the epithelium to occur regularly at sub-sites of the oral cavity which are prone to incidental trauma (cheek mucosa and gum).23 At these sites, regular capillary loops running toward the surface, over the deeper vessels of the chorion (pattern IIa). At these sub-sites, the ECE images were considered normal, whereas similar ECE images seen at other sites were considered indicative of incipient pathological changes. Oral cavity hyperplasia was always considered pathologic when the deeper vascular network escaped visual assessment due to elevated thickness of the epithelium, with only the typical “bobby pin” architecture visible running parallel to the epithelium (pattern IIb).

When dysplasia or squamous cell carcinoma arise from the mucosa, ECE vascular patterns (III and IV) are the same as already observed and described for the whole UADT.

ECE of the oral cavity showed an overall accuracy of 94.6% in the assessment of the precise degree of hyperplastic, dysplastic, and carcinomatous alteration of the mucosa of the larynx.

In 1 patient, the diagnosis of squamous cell carcinoma (ECE vascular pattern IV) was not confirmed by histology (definitive diagnosis of mild dysplasia).

Sensibility, specificity, positive predictive value and negative predictive value in the differential diagnosis between non-malignant (normal mucosa, inflammation and hyperplasia) versus premalignant/malignant (mild-to-moderate dysplasia and squamous cell carcinoma) lesions of the oral cavity were 100%, 93.1%, 93.1%, and 100% respectively.

5.2 Pharynx

Most patients with cancer of the oropharynx and hypopharynx are usually diagnosed in advanced stages.25 However, given the frequent incidence of concomitant inflammatory disease, it can be difficult to diagnose early-stage malignant lesions using standard WL endoscopy.

Physiologically, the soft palate and posterior wall of the oropharynx are lined by non-keratinized stratified squamous epithelium which is supported by an underlying lamina propria and muscular layer. The reticulated lympho-epithelium of the constituents of the Waldeyer’s ring, lacks the orderly laminar structure found in typical stratified squamous epithelium, and it is characterized by coexisting epithelial and lymphoid cells.25

While conventional IEE is capable of demonstrating typical features such as irregular foci of microvascular proliferation projecting to the dysplastic squamous epithelium,27 the use of ECE seems to improve the differential diagnosis between chronic inflammatory lesions, dysplasia and carcinoma.

ECE of the oropharynx and hypopharynx allowed for an optimal study of the capillary loops identified at IEE, and our group of research showed an overall accuracy of 87% and 95.5% respectively in the assessment of the precise degree of the hyperplastic, dysplastic, and carcinomatous alteration of the mucosa.

Sensibility, specificity, positive predictive value and negative predictive value in the differential diagnosis between non-malignant (normal mucosa, inflammation and hyperplasia) versus premalignant/malignant (mild-to-moderate dysplasia and squamous cell carcinoma) lesions of the pharynx were 88.9%, 94.4%, 96%, and 85% respectively.
5.3 Larynx

The larynx is a complex tubular segment of the respiratory system formed by irregularly shaped plates of hyaline and elastic cartilage. It allows air to be directed into the respiratory organs for gas exchange, is responsible for producing vocal sounds (phonation), and plays a role in preventing food and drink from entering the respiratory system.

The laryngeal lumen is covered by a mucosa that forms two pairs of folds: the false and true vocal cords, which extend into the lumen of the larynx. The laryngeal epithelium corresponding to the mechanically exposed areas consists of stratified squamous non-keratinized epithelium. In suprabasal layers of this epithelium, dendritic antigen-presenting Langerhans cells can be found. In the rest of the larynx, the epithelium is ciliated columnar pseudostratified with a rich population of goblet cells. Except for the true vocal cords, the lamina propria consists of rather loose connective tissue and contains groups of small, branched tubuloalveolar glands.

In Reinke’s edema, a chronic inflammatory stimulus leads to a rapid cell turnover and, as a consequence, cells with a lower degree of maturation (usually located within the medium layer of the cord) characterized by nuclei regular in shape and staining, and increased in size, become detectable on the epithelial surface.

Metaplasia and dysplasia of the laryngeal epithelium appear to develop progressively on growing. At sites where the squamous epithelium emerges into the submucosa forming crypt-like formations, it appears to be more hyperplastic and more dysplastic. Metaplasia and dysplasia are mainly extended to the vocal cords and to the laryngeal surface of the epiglottis in heavy smokers. Increased nuclear density, dyschromia, dyskariosis, and even cellular mitoses, can be observed only in severe dysplasia.

The development of IEE methods found a good and reliable application in the diagnostic assessment of the mucosa of the larynx that is generally thin, characterized by superficial neoangiogenic changes of the mucosal vascular network. Hyperplasia and mild-to-moderate dysplasia are typically visible – even when using IEE alone – as low-density dark spots with a still regular arrangement.

Fig. 5.1 Macroscopic IEE view of laryngeal keratosis of the right vocal cord captured with IMAGE1 S™ WL mode (a), CLARA (b), CHROMA (c), CLARA+CHROMA (d), SPECTRA A (e) and SPECTRA B (f).

Fig. 5.2 ECE view (same lesion as in Fig. 5.1) taken at 60x magnification with IMAGE1 S™ SPECTRA A showing a vascular pattern IV with keratosis.

ECE allows to identify leukoplakia or verrucous areas (Figs. 5.1, 5.2) with deeper microvascular changes that are not visible at all at NBI or IMAGE1 S™ without contact view. We believe that ECE has the potential of advancing the concept of in-vivo optical biopsies which can be used in such areas to improve the diagnostic accuracy, but further studies are needed.
Although differential diagnosis between hyperplasia (pattern II) and mild-to-moderate dysplasia (pattern III) can be difficult, the completely subverted vascular architecture which is a consistent trait of squamous cell carcinoma with ‘tree-like’ patterns (pattern IV) should facilitate diagnosis (Figs. 5.3, 5.4).

ECE of the larynx allowed for an optimal study of the capillary loops identified at IEE. Our research group showed an overall accuracy of 92.5% in the assessment of the precise degree of hyperplastic, dysplastic, and carcinomatous alteration of the mucosa of the larynx.

In 2 patients the diagnosis of squamous cell carcinoma (ECE vascular pattern IV) was not confirmed by histology (definitive diagnosis of mild dysplasia).

Sensibility, specificity, positive predictive value and negative predictive value in the differential diagnosis between non-malignant (normal mucosa, inflammation and hyperplasia) versus premalignant/malignant (mild-to-moderate dysplasia and squamous cell carcinoma) lesions of the larynx were 96.7%, 90%, 95.4%, and 92.7% respectively.

ECE appears to be a useful method which allows to better visualize and interpret more precisely the vascular changes in precancerous and cancerous lesions of the larynx.
6.1 Oral Cavity

6.1.1 Premalignant Oral Lesions

The clinical appearance of leukoplakia is that of a white patch or plaque-like lesion on the oral mucosa, resulting from hyperkeratosis or parakeratosis which cannot be removed by scraping and cannot be classified clinically or microscopically as another disease entity.30 Hyperkeratosis makes the interpretation of IEE challenging because of the poor penetration of standard WL through hyperkeratotic tissue. Unlike that of leukoplakia, the clinical appearance of erythroplakia – which literally means ‘red patch’ – is different from leukoplakia due to the absence of a whitish patch-like area. In view of its hypervascularity, such lesions are optimally suited as a diagnostic target for detailed inspection by use of ECE (Figs. 6.1, 6.2).

Case 1

Fig. 6.1 Macroscopic images of lingual dysplasia captured with IMAGE1™ WL mode (a), CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).

Fig. 6.2 ECE views (same lesion as in Fig. 6.1) of a pattern III taken at 60x magnification with various IMAGE1™ modes: WL mode (a), CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).
6.1.2 Oral Squamous Cell Carcinoma

Malignant lesions of the oral cavity have a distinct clinical appearance with signs of bleeding, irregular swelling and infiltration of the surrounding tissue (Figs. 6.3, 6.4).

ECE offers an important aid in the clear identification of the superficial margins of moderately advanced lesions, improving the preoperative diagnostic assessment and, as a consequence, the surgical strategy.

Case 2

Fig. 6.3 Macroscopic IEE views of a squamous cell carcinoma of the left aspect of the tongue captured with IMAGE1 S™ modes CLARA (a), CLARA+CHROMA (b), SPECTRA A (c), and SPECTRA B (d). The enhanced visualization modes of the IMAGE1 S™ system offer a good understanding of the superficial tumor margins.

Fig. 6.4 ECE view (same lesion as in Fig. 6.3) of a pattern IV taken at 60x magnification with IMAGE1 S™ mode SPECTRA A (a) and histologic section (b) of a biopsy sample taken from the site shown in (a).

6.2 Pharynx

6.2.1 Hypopharyngeal Squamous Cell Carcinoma

Case 3

Fig. 6.5 Macroscopic views of a pharyngo-laryngeal squamous cell carcinoma captured with IMAGE1 S™ CLARA mode (a), CLARA+CHROMA (b), and SPECTRA A (c).
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

6.3 Larynx

6.3.1 Benign Laryngeal Lesions

Recurrent respiratory papillomatosis (RRP) is a rare infection caused by human papilloma virus type 6 and 11 that can involve all of the respiratory tract, but the larynx is the most common site affected. Though benign in nature, RRP carries the risk of malignant degeneration.31

Macroscopic IEE intensifies the characteristic visual pattern of the well-known multifocal appearance of laryngeal papillomatosis (Figs. 6.8, 6.9).

Fig. 6.6 The macroscopic IEE view in (a) was captured with IMAGE1 S™ mode SPECTRA B and shows the same lesion as in Fig. 6.5 extending to the left piriform fossa. Panels (b–d) are close-up views of the boxed area in (a) and were captured with IMAGE1 S™ WL mode (b), CLARA+CHROMA (c), and SPECTRA A (d) showing the neoplastic involvement of the anterior piriform fossa. The arrows show a more extensive superficial spread of the lesion visible at SPECTRA modalities.

Fig. 6.7 ECE view of a pattern IV taken at 60x magnification with IMAGE1 S™ mode SPECTRA A. Note the intrapapillary capillary loops (same lesion as in Figs. 6.5, 6.6) which are visible through the keratotic layer.

Case 4
Case 5

In patients with laryngeal papillomatosis, ECE allows a particular type of ‘bobby pin’ to be seen inside the papilloma (Figs. 6.10, 6.11).

Fig. 6.9  Macroscopic IEE views of multifocal laryngeal papillomatosis captured with IMAGE1 S™ WL mode (a), CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).

Fig. 6.10  ECE views of laryngeal papillomatosis (same lesion as in Fig. 6.8) showing the ‘bobby pin’-shaped capillary loops inside the papilloma. The images were taken at 60x magnification with IMAGE1 S™ modes CLARA+CHROMA (a), SPECTRA A (b), and SPECTRA B (c).

Fig. 6.11  ECE views of laryngeal papillomatosis (same lesion as in Fig. 6.9) showing the typical ‘bobby pin’-shaped capillary loops. The images were taken at 60x magnification with IMAGE1 S™ CLARA+CHROMA (a) and SPECTRA A (b).
Surgical excision of the papillomata remains the main therapy for laryngeal papillomatosis, but recurrence is frequent because the human papilloma virus DNA persists in residual epithelium or adjacent, normal-appearing mucosa and likely serves as a reservoir for viral reseeding. Both IEE and ECE evaluation improve the perioperative mapping of sites involved by papillomatosis, allowing the identification of the WL normal-appearing mucosa, to achieve a complete removal, which is complemented by targeted injection of antiviral agents (Fig. 6.12).

Based on the current therapeutic modalities used at our department (first author), patients who are surgically treated for recurrent laryngeal papillomatosis receive intralesional and submucosal injections of Cidofovir under general anesthesia (off-label treatment with 0.75 mg/mL, administered until a maximum of 1–4 mL of the drug or 3 mg/kg, – dependent on the extension of the disease – was introduced in one surgical procedure, according to literature).
6.3.3 Early Laryngeal Squamous Cell Carcinoma

Case 7

Fig. 6.15 Macroscopic IEE views (a–c) and ECE views (d–f) in a patient with laryngeal leukoplakia. Macroscopic IEE views were captured with IMAGE1 S™ WL mode (a), CLARA+CHROMA (b), and SPECTRA A (c). ECE views were taken at 60x magnification with IMAGE1 S™ WL mode (d), CLARA+CHROMA (e), and SPECTRA A (f) and allowed a better understanding of the degrees of the neoangiogenic changes (vascular pattern IV).

Case 8

Fig. 6.16 The macroscopic serial views captured with MAGE1 S™ modes CLARA (a), CLARA+CHROMA (b), SPECTRA A (c) and SPECTRA B (d) allow to delineate more precisely the boundaries of the superficial spread of the lesion.

Fig. 6.17 ECE views (same lesion as in Fig. 6.16) captured with MAGE1 S™ modes CLARA+CHROMA (a), SPECTRA A (b) and SPECTRA B (c) showing a completely subverted vascular architecture of the squamous cell carcinoma with a ‘tree-like’ aspect. According to our ECE scheme, the findings are classified as pattern IV.
Case 9

Fig. 6.18 Macroscopic IEE views of an epiglottic lesion captured with IMAGE1 S™ WL mode (a), CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).

Fig. 6.19 ECE views (same lesion as in Fig. 6.18) captured with IMAGE1 S™ modes CLARA+CHROMA (a), SPECTRA A (b) and SPECTRA B (c) showing a dilated and irregular vascular architecture (pattern IV). Histology allowed the definitive diagnosis of squamous cell carcinoma.

Fig. 6.20 Intraoperative endoscopic view after transoral partial CO₂ laser epiglottectomy.
Case 10

Fig. 6.21 Macroscopic IEE views of squamous cell carcinoma of the glottis captured with IMAGE1 S™ WL mode (a), CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).

Case 11

Fig. 6.22 ECE views of vascular pattern IV (same lesion as in Fig. 6.21) captured at 60x magnification with IMAGE1 S™ modes CLARA+CHROMA (a), SPECTRA A (b) and SPECTRA B (c).

Fig. 6.23 Macroscopic IEE view captured with IMAGE1 S™ SPECTRA B showing a laryngeal squamous cell carcinoma of the left vocal cord with subglottic spread.

Fig. 6.24 IEE close-up views (same lesion as in Fig. 6.23) captured with IMAGE1 S™ modes CLARA+CHROMA (a), SPECTRA A (b) and SPECTRA B (c). The ECE view captured at 60x magnification with IMAGE1 S™ mode SPECTRA B (d) shows a vascular pattern IV.
6.3.4 T2 Laryngeal Squamous Cell Carcinoma

Case 12

Fig. 6.25 Macroscopic IEE views of a squamous cell carcinoma of the left vocal cord captured with IMAGE1 S™ WL mode (a), CLARA (b), CLARA+CHROMA (c), CHROMA (d), SPECTRA A (e), and SPECTRA B (f).

Fig. 6.26 ECE views (same lesion as in Fig. 6.25) captured with IMAGE1 S™ modes CLARA+CHROMA (a) and SPECTRA A (b) confirming the diagnosis of squamous cell carcinoma.

6.3.5 T3 Laryngeal Squamous Cell Carcinoma

Case 13

Fig. 6.27 Macroscopic IEE views of squamous cell carcinoma of the right vocal cord captured with IMAGE1 S™ modes CLARA+CHROMA (a) and SPECTRA A (b), ECE views of the same lesion as in (a, b) captured at 60x magnification with IMAGE1 S™ modes CLARA+CHROMA (a) and SPECTRA A (b) confirming the diagnosis of squamous cell carcinoma.
Case 14

**Fig. 6.28** Macroscopic IEE views of a laryngeal squamous cell carcinoma of the left vocal cord with paraglottic invasion. The series was captured with IMAGE1 S™ modes CLARA (a), CLARA+CHROMA (b), SPECTRA A (c) and SPECTRA B (d).

**Fig. 6.29** ECE views of vascular pattern IV (same lesion as in Fig. 6.28) captured at 60x magnification with IMAGE1 S™ modes CLARA+CHROMA (a), SPECTRA A (b) and SPECTRA B (c).

**Fig. 6.30** Intraoperative endoscopic view after transoral left CO2 laser cordectomy.

Case 15

**Fig. 6.31** Macroscopic IEE views of a laryngeal squamous cell carcinoma. The series was captured with IMAGE1 S™ modes CLARA (a), CLARA+CHROMA (b), SPECTRA A (c) and SPECTRA B (d).
Limitations of the Technique

The endoscopic finding of neoangiogenesis in the UADT should definitely raise suspicion of pathology-related changes of the mucosa. The degree to which the altered mucosa varies from a normal appearance can guide the ENT specialist toward the correct diagnosis.

The presence of vegetating tumor or necrosis in case of a large tumor mass should alert the surgeon to the risk of bleeding when the tip of the contact endoscope is brought into direct contact with the tissue, impairing the view.

In order to reach a sufficient level of competence in the correct interpretation of findings, the trainee needs to go through a learning curve. The use of ECE at 60x magnification facilitates the visual assessment and enables a more precise ‘optical biopsy’.

The issue of post-treatment surveillance of head and neck squamous cell cancer after chemo-radiotherapy or radiotherapy alone has been traditionally considered as one of the most challenging diagnostic tasks even for dedicated and experienced physicians. Previous radiotherapy causes inconstant mucosal and vascular anomalies, as a consequence IEE and ECE findings are difficult to interpret (Fig. 7.1). Therefore, the differential diagnosis between persistent or recurrent disease and/or metachronous lesions versus benign post-actinic alterations is still challenging. More studies are needed to determine the real optimization potential of IEE regarding the accuracy of the method.

Fig. 6.32  ECE view of a pattern IV (same lesion as in Fig. 6.31) taken at 60x magnification with IMAGE1 S™ mode SPECTRA A.

Fig. 6.33  Intraoperative endoscopic view after CO2 laser transoral right supraglottic IVb modified laryngectomy which is extended to the ipsilateral piriform sinus (a). Postoperative view (b) of the same patient (flexible laryngoscopy) at 30-day follow-up control.

Fig. 7.1  Macroscopic IEE view captured with IMAGE1 S™ WL mode (a) and ECE view (b) taken at 60x magnification with IMAGE1 S™ mode SPECTRA B. Both images were captured at the left lateral aspect of the pharyngeal mucosa in a patient previously treated with radiotherapy for hypopharyngeal squamous cell carcinoma, showing irregular capillary loops associated with irregular vessels with irregular vessel dilation and necrosis. Histology did not show recurrence of the malignancy.
Image-enhanced endoscopy represents an important milestone in the diagnosis and management of UADT cancer. ECE improves the investigation of 'spots' usually seen at traditional NBI and/or with an equivalent technology, such as IMAGE1 S™ mode SPECTRA A. Once placed in direct contact with the mucosa, the contact micro endoscope gently is moved over the surface to evaluate the architecture of superficial layers of the mucosal epithelium and its vascular morphology. The learning curve is steep and enables the ENT specialist to use these modalities in a short period of time.

The authors emphasize the continuing importance of a close collaboration between clinicians and the scientific community to develop software for imaging and analysis by improving the knowledge between clinical care and objective results.¹

The major application field of IEE/ECE in the UADT is real-time diagnosis which comprises the following aspects:

- **ECE** diagnosis is a real-time examination during the routine intraoperative workup allowing for a closer a better examination of the lesion as to provide a definitive interpretation.
- Vascular changes detected during real-time examination with ECE are interpreted on the basis of a standardized classification scheme. The outcomes of this assessment should guide the physician to a correct diagnosis in a very high number of cases and help prevent wrong incisional biopsies. Preference should be given to excisional biopsies even in form of wider excisions performed after what is termed an 'optical biopsy'.
- In case of lesions with different vascular patterns, the targeted biopsies can be performed at sites where the magnified vascularity is more consistent with pattern III and IV.
- ECE has been demonstrated to be able to reduce the percentage of involved margins after conservative trans-oral resections, but further studies are needed to precisely assess the efficacy of this application.

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### References


Recommended Set for
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery
**Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery**

**Recommended Instrument Set for Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery**

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Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

8591 AJ KLEINSASSER Forceps, straight, with 2 mm cupped jaws, sheath conically reinforced from distal to proximal end, with cleaning connector, working length 21 cm

8591 CJ Same, curved to right

8591 DJ Same, curved to left

8591 AM KLEINSASSER Miniature Forceps, straight, with 1 mm cupped jaws, sheath conically reinforced from distal to proximal end, with cleaning connector, working length 23 cm

8591 BM Same, curved upwards

8591 CM Same, curved to right

8591 DM Same, curved to left

8591 EM Same, curved upwards to right

8591 FM Same, curved upwards to left

8592 A KLEINSASSER Artery Forceps, with ratchet, with cleaning connector, working length 23 cm

8593 A KLEINSASSER Grasping Forceps, without ratchet, serrated, straight, with cleaning connector, straight, working length 23 cm

8593 B Same, curved to right

8593 C Same, curved to left

8593 E Same, curved upwards

8593 G Same, curved upwards to right

8593 H KLEINSASSER Grasping Forceps, without ratchet, serrated, with triangular jaws, curved upwards to left, with cleaning connector, working length 23 cm

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

8594 BB Same, angled 15°

8594 B Same, angled 45°

8594 C Same, curved to right

8594 D Same, curved to left

8594 E Same, straight, cuts horizontally

8594 AJ KLEINSASSER Scissors, straight, sheath conically reinforced from distal to proximal end, with cleaning connector, working length 21 cm

8594 CJ Same, curved to right

8594 DJ Same, curved to left

8596 P Protector, to protect tissue against unintentional LASER irradiation, curved upwards, round, diameter 5 mm, special matt finish, with suction channel to remove LASER vapors, working length 23 cm

8596 R Same, oval, diameter 7 mm, special matt finish, with suction channel

8606 D Coagulation Suction Tube, with ergonomic handle, insulated, with connection for unipolar coagulation, with Cleaning Stylet 8606 FM, outer diameter 2 mm, working length 23 cm

8606 E Same, outer diameter 2.5 mm

8606 F Same, outer diameter 3.5 mm

8606 K Suction Tube, with ergonomic handle, with distal elevator 18 x 5 mm, for dissecting and retracting tissue, special matt finish, with Cleaning Stylet 8606 FM, outer diameter 3 mm, working length 23 cm

8606 E Grasping Forceps, straight, serrated, sheath insulated, with cleaning connector, working length 23 cm

8663 AH Same, curved to right

8663 BH Same, curved to left

8665 L LARYNGOFORCE® II Clip Forceps, jaws curved to left, with cleaning connector, working length 22 cm, for use with Clip 8665 T

8665 R Same, jaws curved to right

8666 N Clip, titanium LT 200, medium, 5 mm, sterile, package of 36 cartridges with 6 clips each

8654 B 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

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

8595 B Same, oval, angled 45°

8595 C Same, straight, cut, pointed

8595 D Same, golf club-shaped, curved, round

8595 E Same, round, cuts vertically

8595 F KLEINSASSER Hook, blunt, with probe end, working length 23 cm

8596 A Same, sharp

8596 B Same, blunt, angled 90°, length 5 mm

8596 C KLEINSASSER Ligature Needle, curved to right, working length 23 cm

8596 D KLEINSASSER Ligature Needle, curved to left, working length 23 cm

8596 E KLEINSASSER Suction Raspatory, working length 23 cm

8596 F KLEINSASSER Suction Raspatory, working length 23 cm

8596 H KLEINSASSER Knot Tier, working length 23 cm

8596 T KLEINSASSER Knot Tier, working length 23 cm

8596 W Cotton Applicator, straight, working length 25 cm

8596 J Cotton Applicator, for endolaryngeal microsurgery, straight, working length 21 cm

8596 K Cotton Applicator, for endolaryngeal microsurgery, straight, working length 18 cm

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

8598 A KLEINSASSER Injection Needle, LUER-Lock, curved, working length 23 cm

8598 B KLEINSASSER Injection Needle, LUER-Lock, straight, working length 23 cm
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

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

8602 KV Same, ball end, curved upwards

8603 KV Same, ball end, curved upwards,
outer diameter 3 mm,

8598 D PERETTI Injection Needle,
distal end 45° curved upwards, Luer-Lock,
working length 23 cm

8605 N KLEINSASSER Suction and Coagulation Cannula,
outer diameter 3 mm, working length 26 cm,
for use with unipolar High Frequency Cords 26005 M
or 26002 M/26004 M/26006 M

8605 P KLEINSASSER Insulated Cannula,
for suction and coagulation, outer diameter 5 mm,
working length 26 cm, for use with unipolar
High Frequency Cords 26005 M or
26002 M/26004 M/26006 M

840036 Bipolar Coagulation Electrode,
straight, with suction channel, for laryngoscopy,
working length 26 cm, for use with Bipolar High
Frequency Cords 26176 LE or 26176 L – 26176 LV

8575 QS Teeth Protector, silicone, autoclavable,
can also be used as inlay in metal teeth protector

8575 RA Teeth Protector, metal, large

8575 RB Same, medium

8575 RC Same, small

8575 RD Same, extra small

8575 QS Same, 90° curved

8655 A Elevator,
slightly curved, working length 23 cm,
for use with Handle 8597

8655 C Same, 90° curved

8655 K Knife,
lancet-shaped, straight, working length 23 cm,
for use with Handle 8597

PERETTI High Pressure Syringe,
for fat injection

High Pressure Syringe,
for viscous fluid injection

PERETTI High Pressure Syringe,
for fat injection

Injection Cannula,
short tip, Luer-Lock, tip outer diameter 1 mm,
inner diameter 0.7 mm, working length 18 cm,
for single use, package of 3

Same, tip outer diameter 1.3 mm,
inner diameter 1.1 mm

Same, tip outer diameter 1.3 mm,
inner diameter 1.1 mm, working length 15 cm

JOUSSEN Larynx Cannula,
curved, Luer-Lock, tip outer diameter 0.6 mm,
for collagen application, for single use,
package of 3, for use with High Pressure Syringe
771400
HOPKINS® Telescopes

8715 AA
ANDREA-DIAS Contact Micro-Laryngoscope with HOPKINS® Straight Forward Telescope 0°, diameter 5.5 mm, length 23 cm, autoclavable, magnification 1 x, 60 x, 150 x. Fiber optic light transmission incorporated. Color code: green

8715 BA
ANDREA-DIAS Contact Micro-Laryngoscope with HOPKINS® Forward Oblique Telescope 30°, diameter 5.5 mm, length 23 cm, autoclavable, magnification 1 x, 60 x, 150 x. Fiber optic light transmission incorporated. Color code: red.
HOPKINS® Telescopes for Laryngo-Pharyngoscopy

Direction of View 90°

8700 DKA Tele-Laryngo-Pharyngoscope, with integrated HOPKINS® lateral telescope 90°, diameter 5.8 mm, length 20 cm, autoclavable, fiber optic light transmission incorporated, color code: blue

8700 H Handle, for use with Tele-Laryngoscope 8700 CP, 8700 CKA, 8705 CKA and 8700 DKA

Direction of view 70°

8700 CKA BENJAMIN Tele-Laryngoscope, with integrated HOPKINS® lateral telescope 70°, angle of view 50°, diameter 5.8 mm, length 19 cm, autoclavable, fiber optic light transmission incorporated, color code: yellow

8700 H Handle, for use with Tele-Laryngoscope 8700 CP, 8700 CKA, 8705 CKA and 8700 DKA

8705 CKA BENJAMIN Slimline Tele-Laryngoscope, with integrated HOPKINS® lateral telescope 70°, angle of view 50°, diameter 4 mm, length 18 cm, autoclavable, fiber optic light transmission incorporated, color code: yellow

8700 H Handle, for use with Tele-Laryngoscope 8700 CP, 8700 CKA, 8705 CKA and 8700 DKA
HOPKINS® II Telescopes
for Rigid Endoscopy associated with Microlaryngeal Surgery (REMS) according to Prof. ANDREA and Prof. DIAS

- 8712 AA
  HOPKINS® II Straight Forward Telescope 0°, enlarged view, diameter 5 mm, length 24 cm, autoclavable, fiber optic light transmission incorporated, color code: green

- 8713 AA
  HOPKINS® II Straight Forward Telescope 0°, enlarged view, diameter 5 mm, length 29 cm, autoclavable, fiber optic light transmission incorporated, color code: green

HOPKINS® Telescopes
for Autofluorescence / Photodynamic Diagnosis (PDD) during Direct Laryngo-Pharyngoscopy

- 8712 BP
  HOPKINS® II Straight Forward Telescope 0°, enlarged view, for autofluorescence / photodynamic diagnosis (PDD), diameter 5 mm, length 24 cm, autoclavable, fiber optic light transmission and filter exchanger incorporated, color code: green

- 8712 AP
  HOPKINS® II Forward-Oblique Telescope 30°, enlarged view, for autofluorescence / photodynamic diagnosis (PDD), diameter 5 mm, length 24 cm, autoclavable, fiber optic light transmission and filter exchanger incorporated, color code: green

- 8712 CP
  HOPKINS® II Lateral Telescope 70°, enlarged view, for autofluorescence / photodynamic diagnosis (PDD), diameter 5 mm, length 24 cm, autoclavable, fiber optic light transmission and filter exchanger incorporated, color code: yellow

- 495 FP
  Fluid Light Cable, diameter 3 mm, length 250 cm
HAVAS Operating Laryngoscope

8790 A  HAVAS Operating Laryngoscope, with extra light handle, large model, length 17 cm, with connector for Light Carrier 497 HC

8790 B  HAVAS Operating Laryngoscope, with extra light handle, medium model, length 17 cm, with connector for Light Carrier 497 HC

497 HC  HAVAS Light Carrier, with integrated telescope channel diameter 5 mm, for proximal illumination, for use with Laryngoscope 8790 A/B

497 HCS  Telescope Protective Sheath, outer diameter 5 mm, length 20 cm, for use of Light Carrier 497 HC with Telescopes 7230 AA, BA, CA, DA, EA, FA

28162 AKA  HOPKINS® Straight Forward Telescope 0°, enlarged view, diameter 2.7 mm, length 20 cm, autoclavable, with angled eyepiece, fiber optic light transmission incorporated, color code: green
Triangle Anterior Commissure Laryngoscopes

RUDERT Anterior Commissure Laryngoscope, large, 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, (version with wide lumen for special cases)

Same, medium, universal size, (most commonly used model)

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

Suction Tube to remove vapor, for LASER treatment, length 16 cm, for use with Laryngoscopes 8590 AL/BL/CL/DL/JA and 8589 B/C
**DEDO Operating Laryngoscope**

**Special Features:**
- The DEDO laryngoscope enables a view of the glottis from the anterior commissure right to the arytenoid region.
- Thin tube diameter allows universal use in adults.
- The distal end of the laryngoscope is shaped like a rounded “V” for optimal visualization.
- Proximal design provides an excellent view of the anterior commissure.
- Comfortable handle design and low overall weight enables convenient handling.

**Dimensions in mm:**
proximal and distal

- 13.5 x 27
- 20
- 20

**8890 A**
**DEDO Operating Laryngoscope**, with extra light handle, length 18 cm

**8574 LG**
**Fiber Optic Light Carrier**, for distal illumination, length 14 cm, for use with Laryngoscope 8890 A

**8574 LN**
**Suction Tube to remove vapor**, length 14 cm, for use with Laryngoscope 8890 A
Laryngoscope Holders
for Operating Laryngoscopes

8575 K  
**Laryngoscope Holder and Chest Support**, GÖTTINGEN model, with adjustment wheel
including:
**Support Rod**, movable, with metal ring, diameter 9 cm, length 34 cm

8575 KC  
**BENJAMIN-PARSONS Laryngoscope Holder and Chest Support**, GÖTTINGEN model, with adjustment wheel
including:
**Support Rod**, movable, with metal ring, diameter 12 cm and 2 lateral set screws, length 34 cm

8575 V  
**Extension**, GRONINGEN model, for enlargement of opening angle of support rod for overweight patients, angled, length 8 cm, for use with Laryngoscope Holder 8575 K/KC and Laryngoscopes 8574 J – JP / SL – RB, 8576 AA – B, 8580 – 8590, 8661 – 8666
Chest Support
for Laryngoscope Holders

Chest Support, GÖTTINGEN model

8575 L

Support Table, GÖTTINGEN model, for Laryngoscope Holders 8575 K/KC, 8574 KT/KW, autoclavable

including:
Swivel Arm, with movable plate
Holding Rod, for height adjustment
Attachment Blocks, can be mounted on operation table equipped with standard sliding rail 25 x 10 mm
Original KLEINSASSER Instruments for Endolaryngeal Microsurgery

Working length 23 cm

Special Features:
- Distal end thinner than proximal end to provide better viewing
- Sheath conically reinforced from distal to proximal end to increase mechanical stability

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

Same, curved upwards

Same, curved to right

Same, curved to left

Same, with straight cutting edge for tangential removal of polyps on vocal cords edge, curved upwards to right

Same, with straight cutting edge for tangential removal of polyps on vocal cords edge, curved upwards to left
**Original KLEINSASSER Instruments**
for Endolaryngeal Microsurgery

**Working length 21 cm, for adolescents**

![Image of 21 cm instrument](image)

- 8591 AJ: KLEINSASSER Forceps, straight, with 2 mm cupped jaws, sheath conically reinforced from distal to proximal end, with cleaning connector, working length 21 cm
- 8591 CJ: Same, curved to right
- 8591 DJ: Same, curved to left

**Working length 23 cm**

![Image of 23 cm instrument](image)

- 8591 AM: KLEINSASSER Miniature Forceps, straight, with 1 mm cupped jaws, sheath conically reinforced from distal to proximal end, with cleaning connector, working length 23 cm
- 8591 BM: Same, curved upwards
- 8591 CM: Same, curved to right
- 8591 DM: Same, curved to left
- 8591 EM: Same, curved upwards to right
- 8591 FM: Same, curved upwards to left
Original KLEINSASSER Instruments
for Endolaryngeal Microsurgery

Working length 23 cm

Special Features:
- Distal end thinner than proximal end to provide better viewing
- Sheath conically reinforced from distal to proximal end to increase mechanical stability

KLEINSASSER Artery Forceps, with ratchet, with cleaning connector, working length 23 cm

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

8592 A

8593 A

8592 A

8593 A

8593 B

Same, curved to right

8593 C

Same, curved to left

8593 E

Same, curved upwards

8593 G

Same, with triangular jaws, curved upwards to right

8593 H

Same, curved upwards to left
**Original KLEINSASSER Instruments**

for Endolaryngeal Microsurgery

**Special Features:**
- Excellent cutting performance with optimal transfer of strength
- Due to specially ground surface scissor blades stay sharper much longer
- Distal end thinner than proximal end to provide better viewing
- Sheath conically reinforced from distal to proximal end to increase mechanical stability

**Working length 23 cm**

![Image of 8594 A scissors]

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

8594 BB  
Same, angled 15°

8594 B  
Same, angled 45°

8594 C  
Same, curved to right

8594 D  
Same, curved to left

8594 E  
Same, straight, cuts horizontally

**Working length 21 cm, for adolescents**

![Image of 8594 AJ scissors]

8594 AJ  
KLEINSASSER Scissors, straight, sheath conically reinforced from distal to proximal end, with cleaning connector, working length 21 cm

8594 AJ  
Same, curved to right

8594 CJ  
Same, curved to right

8594 DJ  
Same, curved to left
Original STEINER Instruments for Transoral LASER Microsurgery

Special Features:

• Protectors to shield distal mucosa from unintentional LASER irradiation, e.g., protection of the subglottis during LASER resection at the free edge of the vocal cord in unintubated patient. Available in diameter 5 mm and 7 mm, each with an integrated suction tube.

• Unipolar cannula for suction and coagulation, ergonomic handle enables steady and targeted work. Also suitable for dissecting and retracting tissue, insulated, with cleaning styllet and available in diameter 2, 2.5 and 3.5 mm.

• Suction tube with retractor and ergonomic handle for retracting tissue during LASER incisions. The straight distal end may also be used as a shield e.g. for protection of the contralateral vocal cord during LASER resection.

Please note: Simultaneous use of insulated instruments and LASER is prohibited.
Original STEINER Instruments
for Transoral LASER Microsurgery

8663 BH  Grasping Forceps, straight, serrated, sheath insulated, with cleaning connector, working length 23 cm

8663 AH  Same, curved to right

8663 CH  Same, curved to left

8665 L  LARYNGOFORCE® II Clip Forceps, jaws curved to left, with cleaning connector, working length 22 cm, for use with Clips 8665 T

8665 R  Same, jaws curved to right

8665 T  Clip, titanium LT 200, medium, 5 mm, sterile, package of 36 cartridges with 6 clips each, for use with Forceps 8665 L/R, 12067 NL/NR

Please note: Simultaneous use of insulated instruments and LASER is prohibited.
KLEINSASSER Needle Holder
for Endolaryngeal Microsurgery

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

LINDHOLM Forceps, for atraumatic retraction of true vocal cords and false vocal cords, distal end with blunt curved blades, self-retaining, with ratchet and cleaning connector, working length 24 cm
Original KLEINSASSER Instruments
for Endolaryngeal Microsurgery

Working length 23 cm, for use with Handle 8597

8595 A  Knife, oval, straight
8595 B  Same, angled 45°
8595 C  Same, sickle-shaped, curved, pointed
8595 D  Same, straight cut, pointed
8595 E  Same, golf club-shaped, curved, round
8595 F  Same, round, cuts vertically
8596 A  Hook, blunt, with probe end
8596 B  Hook, sharp
8596 C  Hook, blunt, angled 90°, with probe end, length 5 mm
8596 E  Needle, curved to right, working length 23 cm
8596 F  Same, curved to left
8596 H  Suction Elevator, working length 23 cm
8596 T  Knot Tier
8597  KLEINSASSER Handle, for use with 8595 A – 8596 T, 8655 A – K, 8693 A / B

8596 W  Cotton Applicator, straight, working length 25 cm
8596 WJ  Cotton Applicator, for endolaryngeal microsurgery, straight, working length 21 cm
8596 WK  Same, working length 18 cm
**Original KLEINSASSER Instruments**

for **Endolaryngeal Microsurgery**

**Working length 23 cm**

8598 A  
**KLEINSASSER** *Injection Needle*, Luer-Lock, curved, working length 23 cm

8598 B  
*Same*, straight

8602 – 8604  
**KLEINSASSER** *Suction Tube*, outer diameter 2 mm, working length 23 cm

8602 KV 8603 KV  
*Same*, outer diameter 3 mm

**For use with KANTOR-BERCI Video-Laryngoscopes**

8602 KV  
**KLEINSASSER** *Suction Tube*, ball end, curved upwards, outer diameter 2 mm, working length 23 cm

8603 KV  
*Same*, outer diameter 2.5 mm
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

**Instruments for Endolaryngeal Microsurgery**

**Working length 23 cm**

8598 D

**Working length 26 cm**

8605 N/P

8605 N

KLEINSASSER Insulated Cannula, for suction and coagulation, outer diameter 3 mm, working length 26 cm, for use with unipolar High Frequency Cords 26005 M or 26002 M/26004 M/26006 M

8605 P

Same, outer diameter 5 mm

840036

840036

Bipolar Coagulation Electrode, straight, with suction channel, for laryngoscopy, working length 26 cm, for use with Bipolar High Frequency Cords 26176 LE or 26176 L – 26176 LV

8575 QS

Teeth Protector, silicone, autoclavable, can also be used as inlay in metal teeth protector

8575 RA

8575 RB

8575 RC

8575 RD

Teeth Protector, metal, large

Same, medium

Same, small

Same, extra small
Additional Instruments
for Endolaryngeal Microsurgery

8655 A  Elevator, slightly curved, working length 23 cm, for use with Handle 8597

8655 C  Same, 90° curved

8655 K  Knife, lancet-shaped, straight, working length 23 cm, for use with Handle 8597

8597  KLEINSASSER Handle, for use with 8595 A – 8596 T, 8655 A – K, 8693 A / B
PERETTI High Pressure Syringe
for Fat Injection

PIAFI = Primary intracordal autologous fat injection following endoscopic chordectomy for glottal laryngeal carcinoma.

- Chordectomy is the standard treatment for vocal cord carcinoma.
- For voice restoration, it is necessary to reconstruct the vocal cords either with synthetic or autologous material. In the case of the PIAFI technique, fat is injected with the PERETTI-BOLZONI instrument. The syringe for fat harvesting lies in the instrument as in a groove.
- Injection is performed by means of a cogwheel mechanism which releases 0.5 ml fat with each cogwheel click.

Operative procedure:
- In the case of the Peretti technique, the surgeon removes subcutaneous abdominal fat.
- Autologous fat is used for the vocal cords after a few minutes.

Benefits of autologous fat injection:
- No risk of rejection
- Hardly any costs
- No allergic reactions
- Only one operation

771410 PERETTI High Pressure Syringe, for fat injection including:
- High Pressure Handle, for use with Syringe Holder 771412
- Syringe Holder, for Plastic Syringe 771415, for use with High Pressure Handle 27200
- Pusher, for use with High Pressure Handle 27200 with Plastic Syringe 771415
- Plastic Syringe, spring-action, self-retaining, 10 ml, sterile, for single use, package of 25
- Injection Cannula, angular, Luer-Lock, tip outer diameter 1.3 mm, inner diameter 0.8 mm, working length 20 cm, package of 3
High Pressure Syringe
for Viscous Fluid Injection, for Larynx

771400 High Pressure Syringe, for viscous fluid injection
including:
High Pressure Handle, for use with Syringe Holder 27201 Q
Adaptor, for injection of viscous fluid, for filling plastic syringe,
package of 3
Plastic Syringe, 1 ml, for single use, package of 100
Syringe Holder, for plastic syringe, package of 3
Injection Cannula, Luer-Lock, outer diameter of syringe 1.3 mm,
inner diameter 0.8 mm, working length 23 cm, package of 3

27200 SK Injection Cannula, short tip, for single use, Luer-Lock, tip outer
diameter 1 mm, inner diameter 0.7 mm, working length 18 cm, package of 3

27200 SL Injection Cannula, for single use, Luer-Lock, tip outer diameter 1.3 mm,
inner diameter 1.1 mm, working length 18 cm, package of 3

27200 SM Same, working length 15 cm, package of 3

27200 T JOUSSEN Larynx Cannula, curved, for single use, Luer-Lock,
outer diameter of tip 0.6 mm, for collagen application, for use with
High Pressure Syringe 771400 or Syringe 810002, package of 3

Please note: Collages are injected cool. If the material becomes warm it becomes rigid and can not be made liquid again by recooling.
With the IMAGE1 S™ camera platform, KARL STORZ once again sets a new milestone in endoscopic imaging, consolidating their reputation as an innovative leader in minimally invasive surgery. The IMAGE1 S™ camera platform offers surgeons a single system for all applications. As a modular camera platform, IMAGE1 S™ combines various technologies (e.g., rigid, flexible and 3D endoscopy) in one system and can therefore be adapted to individual customer needs. Furthermore, near infrared (NIR/ICG) for fluorescence imaging, the integration of operating microscopes and the use of VITOM® 3D exscopes is possible via the camera platform.

**Brilliant imaging**

- Versatile visualization options for diagnosis and therapy
- Innovative S-Technologies for easy differentiation of tissue structures
- Clear and razor-sharp imaging
- Natural color rendition
- Automatic light source control

**CLARA + CHROMA:** Homogeneous illumination + contrast enhancement

**CLARA:** Homogeneous illumination

**CHROMA:** Contrast enhancement

* **SPECTRA A:** Color hue shift and exchange (filtering reds)

* **SPECTRA B:** Spectral color shift (intensification of greens and blues)

* SPECTRA A: Not available for sale in the U.S.A.
* SPECTRA B: Not available for sale in the U.S.A.
**Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery**

**IMAGE1 S™**
As individual as your requirements

### Innovative Design
- **Side-by-side View**: Parallel display of standard image and visualization mode possible
- **Multiple source management**: Simultaneous control, display and documentation of two image sources possible (e.g., hybrid procedures)
- **Intuitive user guidance**: (dashboard, live menu and setup menu)
- **Intelligent icons display settings and status**
- **Individual presets possible**
- **50 patient data records can be archived**

### Economical and futureproof
- **Modular platform**: Rigid, flexible and 3D technology can be selected according to individual preferences
- **Easy integration of new technologies**
- **Forward and backward compatibility**
- **No additional equipment (e.g., special light sources) required for S-Technologies**

*SPECTRA A: Not available for sale in the U.S.A.*
*SPECTRA B: Not available for sale in the U.S.A.*
IMAGE1 S™
As individual as your requirements

**IMAGE1 S™ 3D**

IMAGE1 S™ 3D is a further component in the IMAGE1 S™ camera platform. The 3D system provides surgeons with excellent depth perception. Furthermore, the 3D stereoscopic imaging system is particularly valuable for activities that demand a high degree of spatial perception. The 3D camera platform from KARL STORZ impresses with its wide range of applications – from laparoscopy, gynecology, ENT to microsurgical interventions.

**Benefits of IMAGE1 S™ 3D**
- Brilliant and razor-sharp imaging in 2D and 3D
- Switchover from 3D to 2D at the touch of a button
- Easy integration into the IMAGE1 S™ platform
- CLARA, CHROMA, SPECTRA* in 2D and 3D
- 3D system with video endoscopes with diameters of 10 mm and 4 mm as well as VITOM® 3D

**Benefits of 3D integration into the IMAGE1 S™ camera platform**
- Communication between all units
- One system for multiple applications
- Reduced space requirements
- One user interface for all applications
- Synergy effects between the OR workflow and financing

* SPECTRA: **Not available for sale in the U.S.A.**
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

Connects all technologies IMAGE1 S CONNECT™

- 10 mm 3D video laparoscope
- 4 mm 3D video endoscope
- Flexible video endoscopes
- 1-chip camera heads
- PDD camera heads
- 2D endoscopy IMAGE1 S™ X-LINK
- 2D endoscopy IMAGE1 S™ H3-LINK
- Near Infrared (NIR/ICG) 3-chip camera head FI
- Microscopy camera head
- Open to future technologies
- 4K/UHD camera heads
- 3-chip camera heads

As individual as your requirements
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

**IMAGE1 S™ Camera System**

**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>HD video outputs</th>
<th>Power supply: 100–120 VAC/200–240 VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format signal outputs</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>LINK video inputs</td>
<td>Protection class: I, CF-Defib</td>
</tr>
<tr>
<td>USB interface</td>
<td>Dimensions w x h x d: 305 x 54 x 320 mm</td>
</tr>
<tr>
<td>SCB interface</td>
<td>Weight: 2.1 kg</td>
</tr>
</tbody>
</table>

**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 Module TC 200EN* including:

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

**Specifications:**

<table>
<thead>
<tr>
<th>Camera System</th>
<th>TC 300 (H3-Link)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported camera heads/video endoscopes</td>
<td>TH 100, TH 101, TH 102, TH 103, TH 104, TH 106 (fully compatible with IMAGE1 S), 22220055-3, 22220056-3, 22220053-3, 22220060-3, 22220061-3, 22220054-3, 22220055-3 (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>
</tr>
<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.
# Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

**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

**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 1/3&quot; CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x 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, $f = 15–31$ 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>

**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

**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 1/3&quot; CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x 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, $f = 15–31$ mm (2x)</td>
</tr>
<tr>
<td>Min. sensitivity</td>
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<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

<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>Wall-mounted with VESA 100 adaption</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
</tbody>
</table>

**Inputs:**

- DVI-D
- Fibre Optic
- 3G-SDI
- RGBS (VGA)
- S-Video
- Composite/FBAS

**Outputs:**

- DVI-D
- S-Video
- Composite/FBAS
- RGBS (VGA)
- 3G-SDI

**Signal Format Display:**

- 4:3
- 5:4
- 16:9
- Picture-in-Picture
- PAL/NTSC compatible

**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>
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

Cold Light Fountains and Accessories

495 FO  Fluid Light Cable, diameter 3 mm, length 180 cm
495 FP  Fluid Light Cable, diameter 3 mm, length 250 cm
495 FS  Fluid Light Cable, diameter 2 mm, length 220 cm

Cold Light Fountain XENON 300 SCB

20133101-1  Cold Light Fountain D-LIGHT P SCB, with integrated KARL STORZ-SCB, high-performance light unit for perfusion assessment and standard endoscopic diagnosis, including a 300 Watt Xenon bulb and KARL STORZ light cable connection, consisting of:

20133720-1  Cold Light Fountain D-LIGHT P SCB, power supply 100 – 125 / 220 – 240 VAC, 50 / 60 Hz
400 A  Mains Cord
20090170  SCB Connecting Cable, length 100 cm
20014130  One-Pedal Footswitch, digital, one-stage
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.
Equipment Cart

Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

**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
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

Notes:
Enhanced Contact Endoscopy (ECE) in Head and Neck Surgery

Notes:
with the compliments of

KARL STORZ — ENDOSKOPE