

Gastroenterological Endoscopy

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Second Edition



Thieme

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Preface

Seven years after the initial publication of our book we now present the second edition. This new edition employs the same proven concept as before. However, its content fully reflects the rapid advances that have characterized the development of gastroenterological endoscopy in recent years. This development is not solely the result of technical progress but has also been driven by an increasing interest in endoscopy of the gastrointestinal tract. It is evident that the number of endoscopic centers has continuously increased in recent years. We note with some satisfaction that this development has embraced every continent. The major endoscopic journals report both increasing subscriptions and increasing submissions of scientific papers. The major emerging economic powers in Asia, such as China and India, have apparently decisively influenced this development. We also note that scientific papers in the field of endoscopy no longer come exclusively from university hospitals, but increasingly from municipal hospitals and private practices as well.

This newly acquired knowledge extends to all aspects of gastroenterological endoscopy that are relevant to the patient: patient preparation prior to examination, premedication, screening of premalignant and malignant lesions, endoscopic diagnosis, and therapy.

Completely new technology and methods have been introduced. Not only has the endoscopist's field of endeavor expanded continuously as a result of this development, it has also undergone significant change.

The magic acronym NOTES has evoked fascination. It refers to transluminal invasive procedures in which the endoscope is advanced through the wall of the organ of approach (stomach, vagina, etc.) to reach the target organ in the abdominal or retroperitoneal space in order to remove the appendix, gallbladder, kidney, etc. Surgical teams that include gastroenterologists now see a completely new field of endeavor unfolding for the intrepid gastroenterological endoscopist.

Colorectal carcinoma is by far the most impressive example of the impact of health care policies on the field of endoscopy. Where colonoscopy is the established method of screening for colon cancer, as in the United States and many European countries, endoscopists are veritably flooded with screenees. Might this not mean that other equally important tasks of the physician are being neglected as a result? Obviously new biomarkers for colon cancer with high sensitivity and specificity are needed to filter out unsuitable candidates so that only those cases where a genuine suspicion exists are sent to colonoscopy.

Naturally, colonoscopy and the removal of adenomas are indispensable established methods of colon cancer screening. However, not every intervention detects precancerous lesions or small malignancies, permitting timely endoscopic or surgical removal. Obviously improvements to endoscopic methodology or completely new methods are required to reduce the number of interval carcinomas to near zero.

Recent findings that flat and dimpled adenomas and certain serrated polyps in the colon entail a higher risk of malignant degeneration are important. Here there is some good news. Clear improvements in the detection of changes in the epithelial surface of the gastrointestinal tract have resulted from enlarging the endo-

scopic image, using dyes, autofluorescence, high-definition endoscopy, and also by manipulating the wavelength of the applied light by means of narrow-band imaging (NBI) and Fujinon intelligent color enhancement (FICE). More precise evaluation of the substrate also permits endoscopic classification of changes as premalignant or malignant lesions; the Paris–Japan and Kudo classifications are convincing examples of such a system. But this is not all. With the aid of confocal laser microscopy it is possible to obtain images of the deeper layer of the intestinal mucosa beneath the epithelial surface. This modality can visualize high-grade dysplasia in ulcerative colitis that might go undetected with white light microscopy. Have we not come very close to many older endoscopists' dream of practicable "endoscopic histology"?

The endoscopic submucosal dissection (ESD) developed by our Japanese friends represents a great advance in both diagnosis and therapy. In contrast to endoscopic mucosal resection (EMR), ESD allows better en bloc resection of the tumor-bearing area of the wall, more precise histopathological diagnostic studies, and a deeper resection. In the first edition of our book we had described endoscopic mucosal resection as a revolutionary advance. Now this elegant method risks being supplanted by endoscopic submucosal dissection. This will hold true especially if the modification suggested by the American Apollo group, namely first marking the affected area of the wall laterally with electrocautery and lifting the wall by inflating a balloon in the submucosa, does indeed increase safety and reduce the time required for surgery.

New imaging modalities such as high-resolution–high-magnification endoscopy, autofluorescence, spectra modulation, etc., and new therapeutic technology were applied in the colon. This novel technology was also applied in other fields such as esophagus, stomach, and bilio-pancreatic area. Particularly Barrett's esophagus was favored to apply and evaluate all novel technology but progress in diagnostic and therapeutic possibilities was also made in the bilio-pancreatic field.

A true novelty in this second edition of the atlas is the in depth description of investigational possibilities for small intestinal diseases with capsule endoscopy and mono- and double balloon endoscopy. The last endoscopic frontier has now been tackled, allowing investigation of the entire intestinal tract, whenever clinically indicated.

In parallel with the amazing endoscopic evolution was the further development of diagnostic and particularly therapeutic endosonography. Something which was unthinkable in the past is now entering the arena of routine procedures in an optimally equipped and skilled endoscopic unit.

The key contributions of the gastroenterological endoscopist to digestive oncology are hardly at risk of being usurped by other disciplines. The situation is different in the case of classic chemotherapy or the application of biologicals by gastroenterologists in advanced gastrointestinal tumors. This is common practice in certain European countries. Indeed, the use of biologicals is hardly new to gastroenterologists used to treating patients with chronic inflammatory bowel disease.

This book addresses all endoscopists throughout the world as well as colleagues from related fields. It is especially intended for our fellows, for gastroenterologists in private practice and those

practicing in tertiary referral centers, who work closely with surgeons, pathologists, radiologists, and oncologists, as well as for all those who are involved in research and participate in clinical studies wherever possible. We are well aware of the great economic differences between the various regions and countries of the world, and we explicitly encourage our colleagues in the developing countries. Our express thanks go to those manufacturers of endoscopes and add-on devices who help to establish gastroenterological and endoscopic training centers for training physicians and assistants in the developing countries.

This edition has seen a change in the group of editors. Jacques Bergman, Alexander Meining, D Nageshwar Reddy, Michael Wallace, and Hisao Tajiri have been brought on board as associate editors in an effort to involve younger endoscopists with solid scientific and clinical reputations, who have already acquired experience and demonstrated sound critical judgment in both research and practice. These colleagues have also played a crucial role in designing the book and will be responsible for the coming editions. We felt it important that they already become familiar with the responsibilities of editors. It is essential for a textbook to keep abreast of the latest developments. New aspects and changing emphasis make it important to enlist younger authors as well. This approach has paid off. However, the majority of our authors

had already contributed to the first edition. We know of few gastroenterological book projects with such a broad international group of contributing authors. The editors would like to thank all the authors for their understanding for our urgent wishes and for their outstanding cooperation.

The high quality of text and image material the editors strived for was nearly invariably achieved. We thank the enthusiastic donors (especially from Japan) for their excellent image material.

We present readers throughout the world with a book that does justice to the advances in medical science and to the development and importance of gastroenterological endoscopy. Gastroenterologists throughout the world will receive the information they require for planning an endoscopy department, for their endoscopic work in both private practice and the hospital, and for detecting and treating even rare pathology in the gastrointestinal tract and major digestive glands.

Our special thanks go to the staff of Thieme Publishers, especially Dr. Wachinger and Dr. Bergman. Ms. Rachel Swift not only did justice to her name, but won the editors' boundless admiration for her knowledge, patience, and kindness. Dr. Hauff was a generous publisher who agreed to give the book an excellent layout.

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Contents

I Development of Endoscopy

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Abbreviations

| | | | |
|-----------------------------------------------------|-----------------|------------------------------------------------|-----------|
| airway breathing and circulation | ABC | cylindrical surface | CS |
| blood transfusion requirement index | ABRI | clinically significant portal hypertension | CSPH |
| American Cystoscope Makers Inc. | ACMI | centimeter | cm |
| acute colonic pseudo-obstruction | ACPO | computed tomography | CT |
| autofluorescence imaging | AFI | computed-tomographic angiography . | CTA |
| American Gastroenterological Association | AGA | diffuse antral gastritis | DAG |
| acute gallstone pancreatitis | AGP | dysplasia-associated lymphoid mass | DALM |
| American Heart Association | AHA | double-balloon endoscopy | DBE |
| acquired immune deficiency syndrome | AIDS | dilated intercellular spaces | DIS |
| autoimmune pancreatitis | AIP | diisopropyl iminodiacetic acid | DISIDA |
| aminolevulinic acid | ALA | dimethyl sulfoxide | DMSO |
| alanine aminotransferase . | ALT | desoxyribonucleic acid | DNA |
| American Medical Association | AMA | direct percutaneous endoscopic jejunostomy | DPEJ |
| analysis of variance | ANOVA | deep venous thrombosis | DVT |
| Asia-Pacific Association for the Study of the Liver | APASL | Erlangen Active Simulator for Interventional | EASIE |
| adenomatous polyposis coli gene | APC | Endoscopy | EBL |
| Argon plasma coagulation | APC | endoscopic band ligation | ECG |
| antireflux device | ARD | electrocardiography | ECL |
| American Society of Anesthesiologists | ASA | enterochromaffin-like | EGC |
| adjustable silicone gastric banding | ASGB | early gastric cancer | EGD |
| American Society of Gastrointestinal Endoscopy | ASGE | esophagogastroduodenoscopy | EGFR |
| aspartate aminotransferase | AST | epidermal growth factor receptor | EGJ |
| arteriovenous malformation | AVM | esophagogastric junction | EHEC |
| BioEnterics Intragastic Balloon | BIB | enterohemorrhagic <i>E. coli</i> | EHL |
| bipolar electrocoagulation | BICAP | electrohydrolic lithotripsy | EHL |
| body mass index | BMI | electrohydraulic lithotripsy | EHT |
| biliopancreatic diversion | BPD | electrohydrothermal [probes] | EIEC |
| biliopancreatic diversion with duodenal switch | BPD-DS | enteroinvasive <i>E. coli</i> | EIS |
| balloon-occluded retrograde transvenous | | endoscopic injection sclerotherapy | ELISA |
| obliteration | BRTO | enzyme-linked immunosorbent assay | ELT |
| bovine spongiform encephalopathy | BSE | endoscopic laser therapy | EMR |
| British Society of Gastroenterology | BSG | endoscopic mucosal resection | EMR-C |
| chronic antral gastritis | CAG | cap-assisted endoscopic mucosal resection | EMR-L |
| computer-assisted personalized sedation | CAPS | ligation-assisted EMR | EP |
| computer-based colonoscopy simulator | CBCS | endoscopic polypectomy | EPAGE |
| common bile duct | CBD | European Panel on Appropriateness of | EPBD |
| charge-coupled device | CCD | Gastrointestinal Endoscopy | EPT |
| colitis cystica profunda | CCP | endoscopic papillary balloon dilation | ERC |
| Crohn disease | CD | endoscopic papillotomy | ERCPC |
| Crohn Disease Activity Index | CDAI | endoscopic retrograde cholangiography | |
| Crohn Disease Endoscopic Index of Severity | CDEIS | endoscopic retrograde cholangiopancreatography | |
| carcinoembryonic antigen | CEA | endoscopic resection using a hypertonic | |
| capsule endoscopy Crohn disease activity index | CECDAI | saline–epinephrine | ERHSE |
| cylindrical insertion | CI | endoscopic submucosal dissection | ESD |
| cytokeratins | CKs | European Society of Gastrointestinal Endoscopy | ESGE |
| columnar-lined lower esophagus | CLE | European Society of Gastroenterology and | |
| confocal laser endomicroscopy | CLE | Endoscopy Nurses and Associates | ESGENA |
| Cytomegalovirus | CMV | endoscopic sphincterotomy | EST |
| carbon dioxide | CO ₂ | extracorporeal shock-wave lithotripsy | ESWL |
| Cyclooxygenase-2 | COX-2 | endoscopic transanal resection | ETAR |
| celiac plexus neurolysis | CPN | enteropathy-type T-cell lymphoma | ETL |
| complete portal tracts | CPTs | endoscopic trimodality imaging | ETMI |
| colorectal cancer | CRC | European Board of Anesthesiology of the | |
| controlled radial expansion | CRE | European Union of Medical Specialists | EUMS/UEMS |
| calcinosis Raynaud phenomenon sclerodactyly | | endoscopic ultrasonography | EUS |
| and telangiectasia | CRST | gastrointestinal endosonography | EUS |

Abbreviations

| | | | |
|----------------------------------------------------|-----------|--------------------------------------------------|--------|
| endoscopic variceal ligation | EVL | ileal pouch–anal anastomosis | IPAA |
| ethylene-vinyl alcohol | EVOH | immunoproliferative small-intestinal disease | IPSID |
| familial adenomatous polyposis | FAP | isosorbide dinitrate | ISDN |
| Food and Drug Administration | FDA | insulated-tip | IT |
| fresh frozen plasma | FFP | IT knife-2 | IT-2 |
| free hepatic venous pressure | FHVP | internal vena cava | IVC |
| Fujinon intelligent chromoendoscopy | FICE | Joule | J |
| fluorescent in-situ hybridization | FISH | jejunoileal bypass | JIB |
| fine-needle aspiration | FNA | jejunostomy through a PEG | JPEG |
| fine-needle aspiration biopsy | FNAB | juvenile polyposis syndrome | JPS |
| fine-needle injection | FNI | potassium titanyl phosphate | KTP |
| fine-needle puncture | FNP | liter | l |
| French size | Fr | laparoscopic adjustable silicone gastric banding | LASGB |
| front surface . | FS | laparoscopic cholecystotomy | LCT |
| gauge | G | laparoscopic–endoscopic procedure | LEP |
| gastric antral vascular ectasia | GAVE | lower esophageal sphincter | LES |
| gastric bypass | GBP | liver function tests | LFTs |
| gastroesophageal flap valve | GEFV | low-grade dysplasia | LGD |
| Garren–Edwards Gastric Bubble | GEGB | lower gastrointestinal bleeding | LGIB |
| gastroesophageal junction | GEJ | low-grade intraepithelial neoplasia | LGIN |
| gastroesophageal reflux disease | GERD | lymphogranuloma venereum | LGV |
| GERD health-related quality of life | GERD-HRQL | laser lithotripsy | LL |
| Groupe d'Etudes Thérapeutiques des Affections | | low-molecular-weight heparin | LMWH |
| Inflammatoires du Tube Digestif | GETAID | low-osmolality nonionic contrast media | LOCM |
| gastroesophageal varices | GEV | laterally spreading tumor | LST |
| gastroesophageal varices | GEVs | <i>Mycobacterium avium</i> complex | MAC |
| gamma glutamyltransferase | gGT | mucosa-associated lymphoid tissue | MALT |
| gastrointestinal | GI | minilaparoscopy-assisted natural orifice surgery | MANOS |
| gastrointestinal stromal tumor | GIST | <i>MUTYH</i> gene-associated polyposis | MAP |
| Global Rating Scale . | GRS | magnetic endoscope imaging | MEI |
| glyceryl trinitrate | GTN | multiple endocrine neoplasia | MEN |
| graft-versus-host disease | GVHD | myocardial infarction | MI |
| gastric variceal obturation | GVO | milliliter | ml |
| highly active antiretroviral therapy | HAART | mechanical lithotripsy | ML |
| hepatitis B virus | HBV | millimeter | mm |
| hepatocellular carcinoma | HCC | mitochondrial neurogastrointestinal | |
| hepatitis C virus | HCV | encephalomyopathy | MNGIE |
| hernia diaphragmatica | HD | main pancreatic duct | MPD |
| high-grade dysplasia | HGD | magnetic resonance cholangiography | MRC |
| high-grade intraepithelial neoplasia | HGIN | magnetic resonance cholangiopancreatography | MRCP |
| hereditary hemorrhagic telangiectasia | HHT | magnetic resonance imaging | MRI |
| hepatoiminodiacetic acid | HIDA | microsatellite instability | MS |
| human immunodeficiency virus | HIV | microsatellite instability | MSI |
| hereditary nonpolyposis colorectal cancer | HNPCC | Men who have sex with men | MSM |
| hereditary nonpolyposis colorectal cancer | HNPCC | methyl <i>tert</i> -butyl ether | MTBE |
| holmium:yttrium–aluminum–garnet | Ho:YAG | temoporfin | mTHPC |
| human papillomavirus | HPV | metaplasia ulceration stricture and esophagitis | MUSE |
| herpes simplex virus | HSV | nucleic acid amplification tests | NAATs |
| hemolytic uremic syndrome | HUS | nurse-administered propofol sedation | NAPS |
| hepatic venous pressure gradient | HVPG | narrow-band imaging | NBI |
| hepatic venous pressure gradient | HVPG | neodymium:yttrium–aluminum–garnet | Nd:YAG |
| The Hygiene in Gastroenterology–Endoscope | | North Italian Endoscopic Club | NIEC |
| Reprocessing study [<i>Hygiene in der</i> | | National Institutes of Health | NIH |
| <i>Gastroenterologie – Endoskop-Aufbereitung</i>] | HYGEA | nanometer | nm |
| herz | Hz | number needed to treat | NNT |
| internal anal sphincter | IAS | Natural Orifice Surgery Consortium for | |
| inflammatory bowel disease | IBD | Assessment and Research | NOSCAR |
| International Conference on Capsule Endoscopy | ICCE | natural orifice transluminal endoscopic surgery | NOTES |
| intravenous indocyanine green | ICG | nonsteroidal anti-inflammatory drugs | NSAIDs |
| intraductal ultrasonography | IDUS | nonselective beta-blockers | NSBBs |
| idiopathic esophageal ulceration | IEU | New York Society for Gastrointestinal Endoscopy | NSYGE |
| immunoglobulin G | IgG | One-Action Stent Introduction System | OASIS |
| immunoglobulin G4 | IgG4 | optical coherence tomography | OCT |
| immunoglobulin M | IgM | World Organization of Digestive Endoscopy | |
| isolated gastric varices | IGVs | [Organisation Mondiale d'Endoscopie Digestive] | OMED |
| international normalized ratio | INR | ortho-phthalaldehyde | OPA |

| | | | |
|------------------------------------------------------|-----------|-----------------------------------------------|---------------|
| over-the-wire | OTW | squamous cell carcinoma | SCC |
| picture archiving and communication system | PACS | specialized columnar epithelium | SCE |
| analogue broadcasting systems | PAL and | squamocolumnar junction | SCJ |
| | NTSC | submucosal endoscopy with mucosal flap | SEMF |
| periodic acid–Schiff | PAS | self-expanding metal stent | SEMS |
| patient-controlled analgesia–sedation | PCAS | self-expanding plastic stent | SEPS |
| polymerase chain reaction | PCR | Simple Endoscopic Score for Crohn Disease | SES-CD |
| photodynamic therapy | PDT | sphincter of Oddi dysfunction | SOD |
| percutaneous endoscopic cecostomy | PEC | stigmata of recent hemorrhage | SRH |
| percutaneous endoscopic colostomy | PEC | solitary rectal ulcer syndrome | SRUS |
| percutaneous endoscopic gastrostomy | PEG | secretin stimulation MRCP | ss-MRCP |
| polyethylene glycol–electrolyte solution | PEG-ELS | sodium tetradecyl sulfate | STD |
| percutaneous endoscopic jejunostomy | PEJ | stone–tissue discrimination system | STDS |
| positron-emission tomography | PET | sexually transmitted proctitis | STP |
| porfimer sodium | Photofrin | Tissue Apposition System | TAS |
| percutaneous liver biopsy | PLB | target-controlled infusion | TCI |
| pseudomembranous colitis | PMC | transendoscopic microsurgery | TEMS |
| peroral cholangioscopy | POC | transforming growth factor- β | TGF- β |
| pulsatile organ perfusion | POP | transoral incisionless fundoplication | TIF |
| proton-pump inhibitors | PPI | transjugular intrahepatic portosystemic shunt | TIPS |
| protoporphyrin IX | PpIX | transjugular liver biopsy | TJLB |
| positive predictive value | PPV | transient LES relaxations | tLESRs |
| packed red blood cells. | PRBC | tumor necrosis factor- α | TNF- α |
| primary sclerosing cholangitis | PSC | tumor node metastasis | TNM |
| percutaneous transhepatic biliary drainage | PTBD | transoral gastropasty | TOGA |
| percutaneous transhepatic cholangiography | PTC | total pancreatectomy with islet cell | |
| percutaneous transhepatic cholangiographic drainage | PTCD | autotransplantation | TP-IAT |
| percutaneous transhepatic cholangioscopy | PTCS | through-the-scope | TTS |
| polytetrafluoroethylene | PTFE | ulcerative colitis | UC |
| percutaneous transhepatic papillary balloon dilation | PTPBD | ursodeoxycholic acid | UDCA |
| percutaneous ultrasound guidance | PUG | ultrasonography | US |
| Quality Assurance of Hygiene in Endoscopy | | vertical banded gastropasty | VBG |
| [Qualitätssicherung der Hygiene in der Endoskopie] | QSHE | video capsule endoscopy | VCE |
| randomized controlled trial | RCT | variant Creutzfeldt–Jakob disease | vCJD |
| radiofrequency | RF | vascular endothelial growth factor | VGEF |
| Robotics Interactive Endoscopy Simulation | RIES | Watt | W |
| relative risk | RR | automated washer-disinfectors | WDs |
| Roux-en-Y gastric bypass | RYGB | wedged hepatic venous pressure | WHVP |
| Society of American Gastrointestinal | | walled-off pancreatic necroses | WOPNs |
| Endoscopic Surgeons | SAGES | | |
| small bowel endoscopy | SBE | | |

Development of Endoscopy

Section editors:

Meinhard Classen, Guido N.J. Tytgat, Charles J. Lightdale

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1 Two Centuries of Digestive Tract Endoscopy: a Concise Report

Meinhard Classen

Introduction

This report on the fascinating recent history of digestive tract endoscopy, its pioneers, and the sometimes revolutionary discoveries and developments that have been seen in the field makes no claim either to completeness or to absolute accuracy. In his excellent book on the history of endoscopy, Francisco Vilardell draws attention to the uncertainties involved in identifying the real originator of any method—whenever this author fails, it should always be regarded as a matter of *nescientia* rather than *ignorantia*. Important and first-rate histories of the field have been written by Irvin M. Modlin (*A Brief History of Endoscopy*) and Francisco Vilardell (*Digestive Endoscopy in the Second Millennium*)—books that can be strongly recommended to every endoscopist [1,2].

Nineteenth-Century Pioneers

Philipp Bozzini (1773–1809), a physician responsible for public health in Frankfurt am Main in Germany, is recognized as the founding father of endoscopy. The light-conducting system which he developed in 1806 and used to inspect the orifices featured a candle and a system of prisms (**Fig. 1.1**) [3]. A better light source was provided in 1853 by the alcohol–turpentine lamp used for cystoscopy by Antonin Desormeaux (1815–1894). The same light source was used in 1868 by Adolph Kussmaul (1822–1902, **Fig. 1.2**) [4], for the first examination of the esophagus, in a sword-swallower—with a rigid endoscope, of course.

The year 1879 is celebrated as heralding the birth of modern endoscopy, when Max Nitze (1848–1906) presented his *Blasenspiegel*, a cystoscope. The device included a distal platinum lamp and a magnifying optical system and was also capable of being used in the rectum. The surgeon Johannes von Mikulicz-Radecki (1850–1905, **Fig. 1.3**), is regarded as the pioneer of gastroscopy [5]. He was able to identify the pylorus and visualize carcinomas in the stomach.

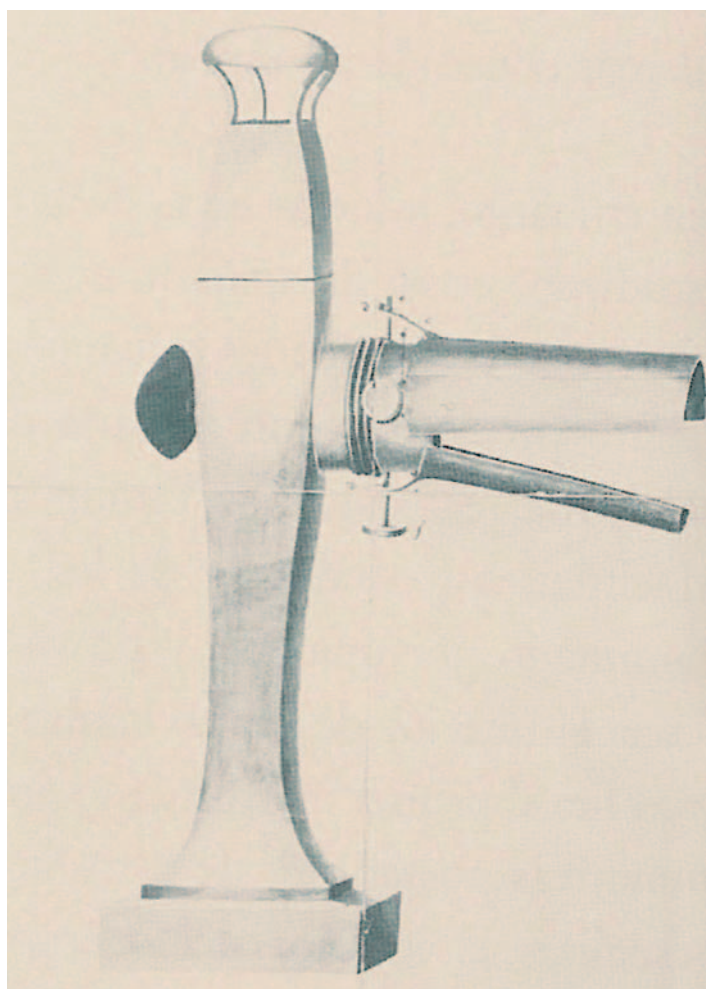


Fig. 1.2 Adolf Kussmaul (1822–1902).

◁ **Fig. 1.1** The original sketch of the light conductor, drawn by Philipp Bozzini himself.

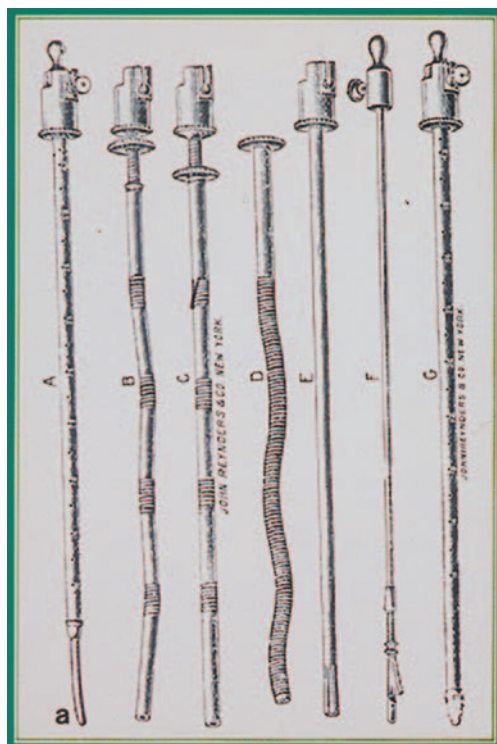
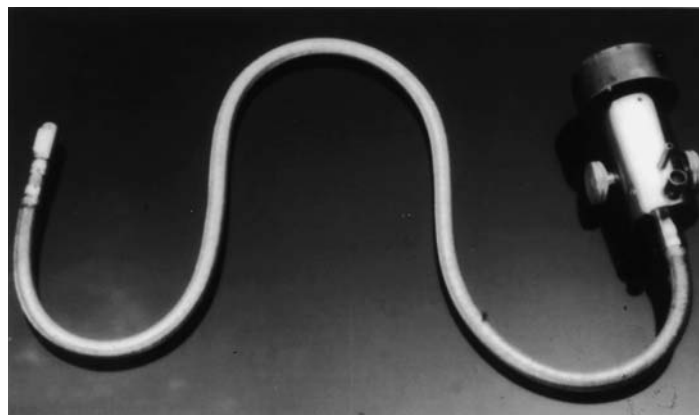


Fig. 1.3 Johannes von Mikulicz's esophagoscope, 1881.

The light bulb invented by Thomas Edison in 1870 was quickly incorporated into endoscopes. The next generation of endoscopes, from the workshop of instrument-maker Josef Leiter (1830–1892) in Vienna, was used for many generations for esophagoscopy, bronchoscopy, and thoracoscopy. With the technology available at the time, numerous further attempts to reduce the rigidity of the instruments, improve illumination conditions, and overcome the limited visualization in the organs being inspected remained unsuccessful.

Rudolf Schindler and the “Semiflexible” Endoscope

In 1932, Rudolf Schindler (1888–1968, **Fig. 1.6**), together with the instrument-maker Georg Wolf (1873–1938), developed a gastroscope in which the proximal end was still rigid but the distal end was capable of being angled up to 34° , so that it was slightly easier to introduce it into the stomach (**Fig. 1.5**) [6]. When using a successor model to this device, I personally found that passage of the instrument was not very easy—particularly in older patients with a short neck, limited cervical spine mobility, large teeth, and a small mouth. In addition, it was not possible to visualize the esophagus and duodenum at all, and only limited inspection of the stomach was possible. Later developments, such as the modification described by Norbert Henning (1896–1985), included a biopsy channel and a facility for photographic documentation [7]. The watercolor illustrations that had been used to record pathological findings before this are evidence of the artistic skills of Schindler and of Henning, as well as those of an endoscopy nurse working with the French gastroscopist François Moutier (1881–1961, **Fig. 1.7**). Schindler suffered the tragic fate of many refugees from Nazi Germany, after being imprisoned in the concentration camp in Dachau for 6 months in 1934. He left Germany and made a new home in the United States. Even today he is still honored as a missionary in the cause of endoscopy, and as the founder of the American Society for Gastrointestinal Endoscopy—thanks in particular to his charismatic qualities as a teacher. He died in Munich in 1968.



a



b

Fig. 1.4 Two gastroscopes.

a The prototype for the fiber gastroscope (1957).

b The first commercial Hirschowitz fiber gastroscope (1961).

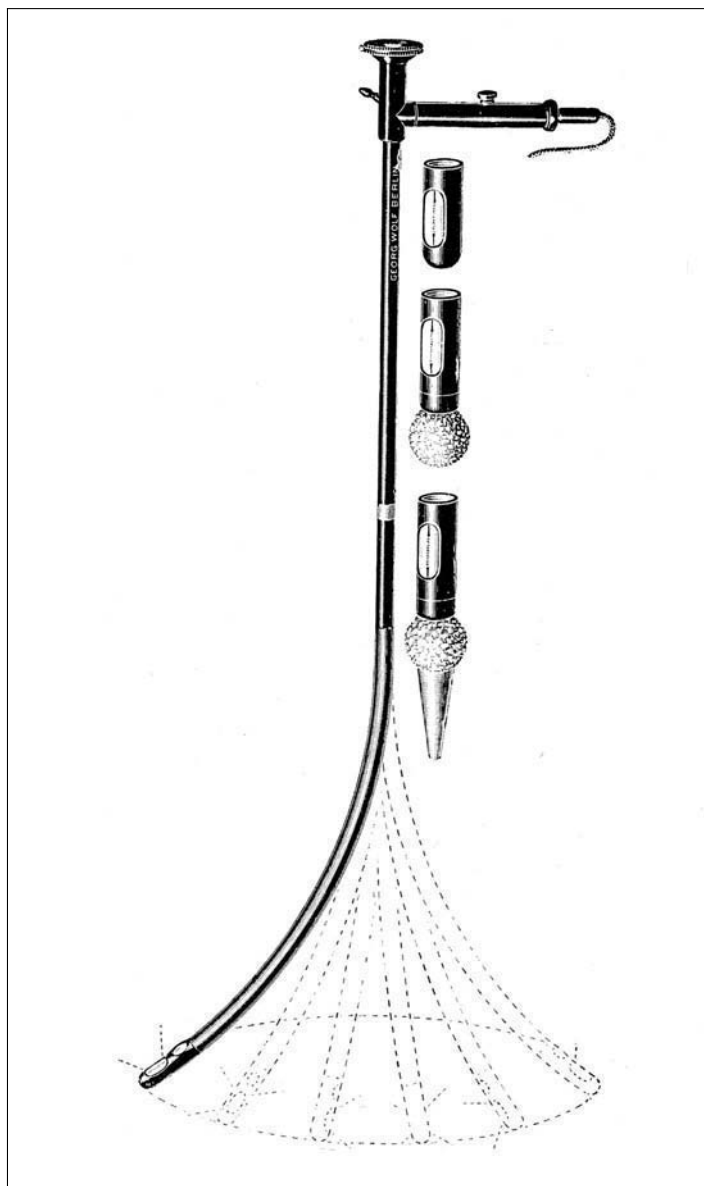


Fig. 1.5 The semiflexible Wolf-Schindler gastroscope (1932).



Fig. 1.6 Rudolf Schindler performing a gastroscopy, with his wife Gabriele holding the patient's head.

Fiberglass Endoscopy and Electronic Endoscopy

The watershed in endoscopy was the development of the fully flexible fiber endoscope by Basil Hirschowitz and colleagues [8]. Heinrich Lamm, a student in Munich, had already developed a model for transmitting light through glass fibers as early as 1927, which he showed to Rudolf Schindler [9]. In 1954, Hopkins and Kapany reported in the journal *Nature* on light transmission through a bundle of parallel glass fibers [10]. The decisive advances that followed involved the use of high-quality clear fiberglass and the isolation of each fiber to prevent light from crossing into neighboring fibers. The problems involved were overcome by Basil Hirschowitz's associates, and by Lawrence E. Curtiss in particular [11,12], and in 1957 the first laboratory prototype of a fiber gastroscope was able to produce a recognizable image of President Lincoln on an American stamp (**Fig. 1.4a; Fig. 1.8**).

Several years then passed before American Cystoscope Makers, Inc. (ACMI) developed an industrial product based on the prototype. A few years later, an instrument channel and Bowden cables for controlling the tip of the instrument were incorporated into it. In 1963, an esophagoscope with a second fiberglass bundle for transmitting light (cold light) was developed, followed by a "panendoscope" with prograde viewing that also made it possible to inspect the duodenum. It should also be mentioned that Rudolf Ottenjann, Rita Hohner, and H. Petzel in 1966 attached Bowden cables to the fiber gastroscope available at the time, which was flexible but had not hitherto been controllable, to allow regular visualization of the cardia by inverting the tip of the instrument [13].

Fiberglass endoscopes were quickly developed for inspection of the colon as well. Initial attempts to advance a fiberglass endoscope as far as the cecum were made by Provenzale and Revignas [14]. They used a plastic thread for the purpose; following peroral passage of the thread through the stomach and bowel, the colonoscope was pulled up on it into the right colon. In 1963, Overholt in the USA had already inspected the rectum and sigmoid using a fiberglass endoscope [15].

In electronic or video endoscopy, the coherent fiberglass bundle for image transmission is replaced with a tiny chip camera at the tip of the instrument. The American company Welch Allyn manufactured the first usable device of this type in 1983 [16–18]. The new types of device made by Japanese manufacturers took the world of endoscopy by storm. These instruments made the endoscopist's work easier by providing binocular vision and allowed many types of image processing and image alteration. The final domains reserved for fiberglass endoscopy—the narrow lumina in the bronchi and intrahepatic bile ducts, as well as in the pancreatic ductal system—have now also been conquered by chip endoscopes with a diameter of 1 mm.

Japanese Contributions to Digestive Tract Endoscopy

An early gastrocamera that had been developed by F. Lange and N. Meltzing in 1893 was unsuccessful, as it only provided monochrome images [19] (**Fig. 1.9**). By contrast, the gastrocamera produced by Tatsuro Uji together with the Olympus Optical Co. in Tokyo in 1952 provided the technology that allowed mass screening examinations to be carried out for early recognition of gastric cancer in Japan [20]. Keiichi Kawai and colleagues developed an endoscopic classification of early gastric carcinomas and were also able to show that these lesions develop further to become advanced carcinomas. Mass screening appears to have significantly reduced the mortality due to gastric cancer in Japan. Pioneering advocates of the gastrocamera



Fig. 1.7 Watercolors of pathological gastric findings made by endoscopy nurse Claire Escoube with François Moutier after a glimpse through the gastroscope (1925).



Fig. 1.8 The first photo taken through the new prototype instrument in 1975—a stamp showing President Lincoln.

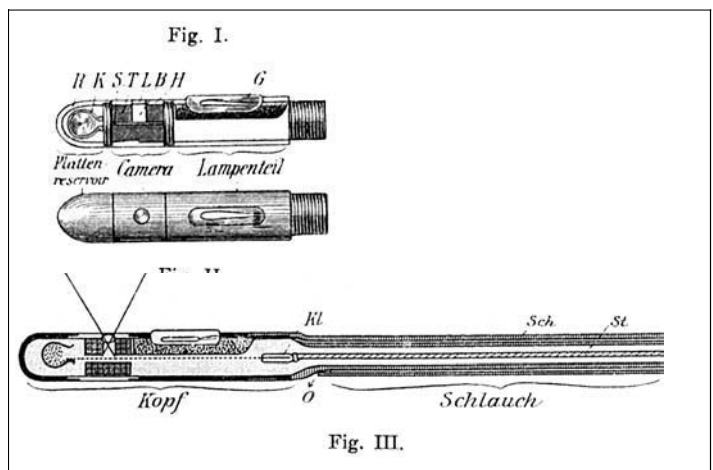


Fig. 1.9 Design drawing for the Meltzing and Langer gastroscope (1898).

in Germany included K. Heinkel, A. Oshima, and U. von Gaisberg, but in contrast to endoscopy a breakthrough with this type of device was not achieved in Germany [21].

The history of endoscopy in Japan began with the purchase of a Hirschowitz gastroscope by Professor Kondo of Tokyo Women's Medical College in 1960. Kondo had to purchase the device personally, as no academic or other institutions were willing to accept the cost. But things then started to move very quickly. The powerful optical industry in Japan was able to offer a fiberglass gastroscope as early as 1963, and in 1966 the device became available with an angling mechanism and a biopsy channel (the GF-B model by Olympus Optical Co., **Fig. 1.10**). The achievements of Japanese gastroenterologists and instrument manufacturers are evident throughout the present volume.

Colonoscopy

Initial efforts to construct a colonoscope were made as early as 1964 by Hirohumi Niwa, together with the Olympus Optical Co. [22]. Niwa's device was intended for the left colon, but Matsunaga was already planning an endoscope that would allow examination of the whole colon—although it was only able to reach the right colon in 8% of cases. Via numerous stages of development, a colonoscope approaching today's standard was ultimately developed, with an angle of vision of 140°, 160–80° angulation, and a diameter of 13.8 mm; the shaft had varying degrees of flexibility [23].

Numerous auxiliary instruments to make it easier to advance the device through the entire colon, such as stiffening wires and “sliding tubes,” were proposed, but none of these was able to replace fluoroscopic guidance. The guidance method available today, using a magnetic localization system (the Olympus ScopeGuide three-dimensional control system), works without X-ray exposure and is particularly useful in helping beginners to reach the cecum or terminal ileum more quickly, and for recognizing and eliminating loops and loop formation. The localization system also makes it possible to precisely locate findings for subsequent surgical interventions [24].

As a completely new method, colonoscopy immediately attracted a great deal of attention. The major diseases of the large bowel and terminal ileum, such as polyps, carcinoma, chronic inflammatory bowel diseases, infectious and ischemic colitis, were redefined and reevaluated. The advantages of direct inspection of the bowel lumen and the use of auxiliary devices and methods—such as biopsy forceps, electrical snares, coagulation probes, injection needles, chromoscopy, mucosectomy, and balloon dilation—have become evident during the last few decades. In addition to the diseases mentioned above, diverticulitis, collagenous colitis, microscopic colitis, localization and treatment of occult bleeding sources such as vascular malformations, etc., were also redefined. Removal of colonic adenomas was identified as a method of pre-

venting colorectal carcinoma [25,26], and monitoring of chronic inflammatory bowel diseases was recognized as important for recognizing dysplasias and carcinomas as early as possible. Identifying the causes of unclear diarrhea and bleeding sources are also important indications for colonoscopy today.

In addition to Christopher Williams in England [23], the pioneers of colonoscopy include Hirohumi Niwa (Japan) [22], Bergein Overholt [15], Hiromi Shinya [27] and Jerome Waye [26] in the USA, and the innovative figures of Peter Deyhle [25] and Peter Frühmorgen in Ludwig Demling's research group in Erlangen, Germany [28]. The clinical and scientific work of V.P. Strekalovskii (Moscow) is little known in Western countries.

Endoscopic Retrograde Cholangiopancreatography

The Americans McCune, Shorb, and Moscovitz [29] published the first report of successful exploration of the papilla of Vater (the major duodenal papilla) and retrograde demonstration of the ductal system opening there. However, the quality of the radiographs obtained with an Eder fiberoptic duodenoscope was so poor that Ludwig Demling and I felt unable to definitely identify a cholangiopancreatography on them. Using a fiber endoscope made by the Wolf Knittlingen company, we were also only able to probe the papilla of Vater in one patient in April 1970, and instillation of contrast medium into the pancreatic duct was incomplete. It was only when the Machida and Olympus companies in 1970 offered duodenoscopes with good optical characteristics and a mechanism for omnidirectional angulation that reliable introduction of the device into the duodenum, location and intubation of the papilla of Vater, and selective intubation of the ducts became routine. The papers presented by Itaru Oi on endoscopic retrograde cholangiopancreatography (ERCP) at the World Congress for Gastroenterology and Endoscopy held in Copenhagen in 1970 were the sensation of the conference [30] (**Fig. 1.11a–c**, **Fig. 1.13**). For the first time, gastroenterologists were now able to reliably diagnose morphological changes caused by diseases of the hepatobiliary and pancreatic ductal systems. Our own group received a JFB-1 instrument from Olympus in November 1970, and by the end of that year we had been able to demonstrate one or both ductal systems in 16 of 20 attempts [31]. Numerous research groups all over the world did pioneering work in identifying the potentialities and risks of ERCP. Pioneers alongside Kawai and Kawajima included Ogoshi et al. [32] and Fujita et al. [33] in Japan; N. Soehendra and E. Seifert in Germany; P.B. Cotton and P. Salmon in the United Kingdom; C. Liguory in France [34]; M. Cremer in Belgium [35]; L. Safrany in Hungary; J. E. Geenen, J. Vennes, and D. Zimmon in the USA; and G.C. Caletti in Italy (see references in the relevant chapters).

In 1976, an endoscopic piggyback system (the mother-and-baby scope) for cholangioscopy was presented by Olympus Optical Co. [36]. The mother device was introduced into the duodenum, and the thin baby scope (with an outer diameter of 2 mm) was then introduced through the papilla of Vater into the bile duct for direct inspection.

Percutaneous Transhepatic Cholangiography

In 1921, Hans Burkhardt and Walter Müller (surgeons in Marburg, Germany) for the first time injected a fluid contrast medium percutaneously into the gallbladder and bile ducts [37]. In 1937, the French surgeon Pierre Husard in Hanoi and his Vietnamese colleague Do-Xuan Hop were also able to inject Lipiodol into the bile ducts via a percutaneous transhepatic route [38]. An important pioneer in this field was Kunio Okuda, who was the first to combine



Fig. 1.10 A fiber gastroscope from the early 1970s, with omnidirectional angulation (Olympus GIF-D).

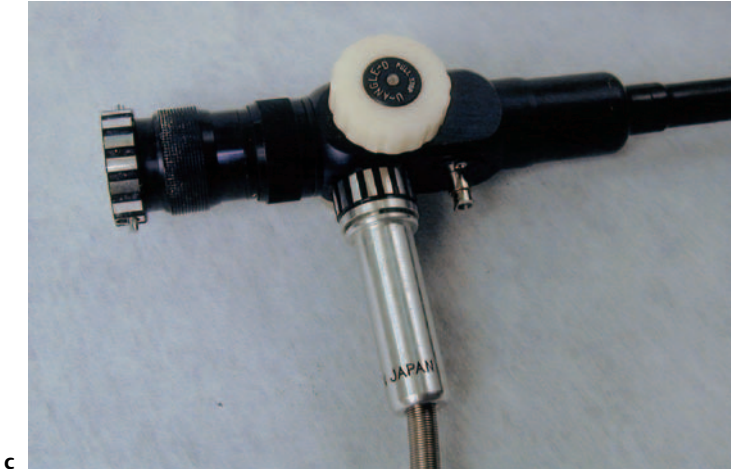


Fig. 1.11 The Machida duodenoscope with which Itaru Oi worked—an elegant but difficult device.

1

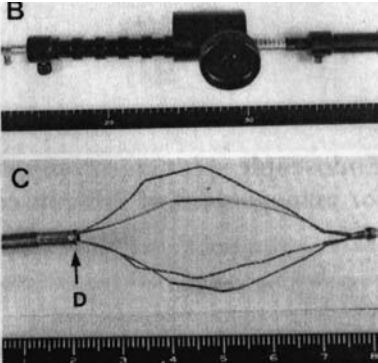
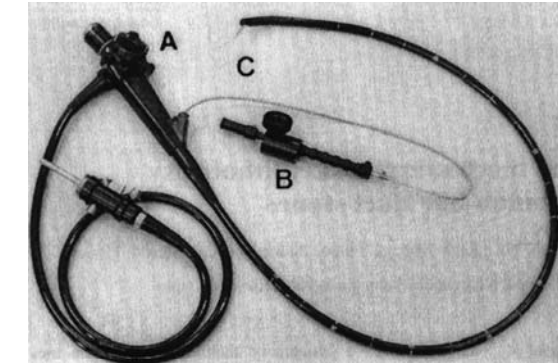


Fig. 1.12 An Olympus duodenoscope with a mechanical lithotripter (B, C & D).

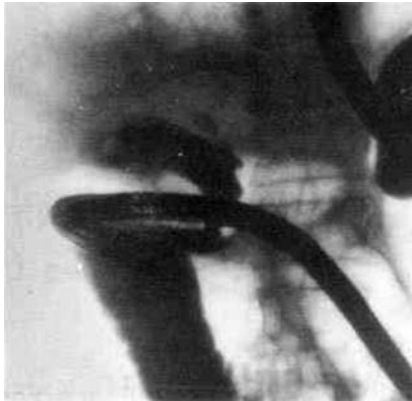


Fig. 1.13 The first images showing endoscopic retrograde cholangiopancreatography, which Itaru Oi presented at the Fourth World Congress of Gastroenterology in Copenhagen, 12–18 July 1970.

percutaneous cholangiography with external biliary drainage [39]. The Swedish surgeon Karl Ludvik Wiechel was the first to introduce percutaneous transhepatic cholangiography into more or less routine practice in Europe [40], succeeding against strong resistance.

ERCP, which entered clinical practice in 1970, did not make the percutaneous access route superfluous, as ERCP examinations (or at least complete examinations) were not possible in quite a few patients with biliary strictures, as well as in patients in whom access to the papilla of Vater was difficult. In 1975, Yamakawa et al. [41] first described the technique of percutaneous transhepatic cholangioscopy, which is still in use today. Stabilization of the puncture channel using mandrins, and subsequent enlargement of it up to 10–12 Fr in two or three steps over a period of 8–10 days, made it possible to introduce flexible cholangioscopes, which were initially equipped with fiberglass but now have charge-coupled device (CCD) chips for image transmission. This approach made it possible to carry out all of the therapeutic manipulations in the intrahepatic and extrahepatic biliary system that were difficult using the route through the papilla of Vater. These include lithotripsy (mechanical, electrohydraulic, and laser), stricture dilation, and tumor ablation.

However, the visual facilities provided by cholangioscopy were limited, illumination was poor, and breaks in the glass fibers led to reduced visibility, as did the yellow discoloring of the glass fibers caused by X-rays. By contrast, the new 1-mm thin chip endoscopes that have been available since 2003 for the same target area provide a clear view into the thin lumina.

Enteroscopy

For a long period, the small bowel stubbornly resisted every effort that was made to achieve complete inspection of it with flexible instruments. Initial attempts were made in 1972, when we managed to guide a 2-m long fiber endoscope through the entire gastrointestinal tract over a swallowed nylon thread [42]. Our efforts to inspect the small bowel remained incomplete, as there were a few regions that “raced past” the lens, and due to the nylon thread it was not always possible to distinguish definitively between superficial mucosal lesions and relevant changes. Complete visualization of the small bowel was still not possible later on, with push enteroscopy and probe enteroscopy. For intraoperative enteroscopy, it was necessary to know in advance at least the segment of the bowel in which a lesion was suspected.

Capsule endoscopy, developed by the ingenious Paul Swain and Given Imaging, Ltd., has now solved diagnostic problems in small-bowel diseases such as occult bleeding sources, tumors, and Crohn's disease lesions that cannot be identified with other methods. It can be usefully supplemented with enteroscopy using one or two balloons, and the latter method also allows biopsies and therapeutic interventions to be carried out [43,44].

Therapeutic Endoscopy

Endoscopy only played a very minor role, if any, in gastrointestinal diagnosis before 1960, but the diagnosis and treatment of numerous digestive tract diseases would be inconceivable without it today. It would be unthinkable nowadays for a gastroenterologist not to have good endoscopic skills, including skills in therapeutic endoscopy.

Foreign-body removal from the digestive tract viscera is the oldest method in therapeutic endoscopy. As early as 1906, Hugo Starck reported on 73 cases of foreign-body extraction from the esophagus [45]. He and Jean Guisez [46] were the pioneers of the method (Fig. 1.14). Today, it is primarily children and prisoners who swallow foreign bodies, and as long as these remain in the upper gastrointestinal tract, including the duodenum, they can be extracted

endoscopically using special auxiliary devices. Foreign bodies introduced into the rectum can also be mobilized and extracted by the endoscopist. General anesthesia and laparotomy are now only rarely needed for treatment of foreign bodies.

Esophageal dilation can now also be regarded as a method of only historical interest. The Starck dilator—a construction resembling an umbrella—was used right up to the 1970s for achalasia, as was the Gottstein balloon. Starck also popularized the method of bougienage of long esophageal strictures—e.g., strictures due to caustic injuries. Hard cicatricial strictures in the esophagus used to be incised using an endoscopically controlled esophagotome. All of these procedures were guided using a rigid esophagoscope, and this continued to be quite customary in some otorhinolaryngology departments even up to the 1990s. Gastroenterologists, by contrast, were already using fiber endoscopy for foreign-body extraction and controlled balloon dilation at the end of the 1960s [47]. The balloons that are in use today have a ring-shaped mark to allow precise endoscopic and/or fluoroscopic positioning within the stricture. Modern treatment of achalasia using botulinum toxin (Botox) is based on the principle of reducing the pressure in the lower esophagus [48].

Palliative treatment of malignant stenoses is another of the older methods in therapeutic endoscopy. Endoscopic stent treatment for stenotic esophageal tumors was developed to clinical maturity by Atkinson and Ferguson [49] and by Guido Tytgat's group in Amsterdam [50]. The earlier plastic stents have now been replaced with self-expanding metal stents. The first description of the use of a spiral metal stent was published in 1982 by Eckart Frimberger, who was then still a member of Rudolf Ottenjann's research group [51]. Covered metal stents with small hooks at each end are usually able to hold the metal stent in the desired position and are often also used to close esophagobronchial fistulas.

The procedure of hemostasis with palliative ablation of stenotic tumor tissue using neodymium:yttrium–aluminum–garnet (Nd:YAG) laser coagulation was originally developed by Kieffhaber et al. [52]. This method is now only rarely used, in stenoses that are barely passable.

Photodynamic diagnosis and treatment. Initial experimental treatments with fluorescent dyes were carried out as long ago as 1903 [53]. In premalignant and malignant epithelial structures, porfimer sodium (Photofrin) and Δ -aminolevulinic acid (ALA) enhance more strongly than in the normal neighboring epithelium. This characteristic can be helpful for diagnosis and targeted treatment in patients with chronic inflammatory bowel diseases, and particularly in ulcerative colitis and Barrett's epithelium with circumscribed high-grade dysplasia/carcinomas that are difficult to recognize endoscopically. Marianne Ortner was the first to use photodynamic diagnosis and therapy in patients with biliary malignancies [54].

Endoscopic polypectomy. The origins of endoscopic polyp removal using rigid esophagoscopes and rectoscopes are difficult to trace, but certainly go back a long time. Following the introduction of fiber colonoscopy, Hirohumi Niwa in Tokyo was able in 1968 to remove colonic polyps using an isolated biopsy forceps (hot biopsy), and later using a coagulation probe. In 1969, he reported at a conference of Japanese endoscopists on the first snare polypectomies in the colon, although these were apparently unsuccessful [55]. His research was obstructed for several years when protesting students barricaded his laboratory door. The first fiber-endoscopic polypectomies in the colon were carried out by Peter Deyhle and colleagues [56] in 1970, and procedures in the stomach were reported in 1971 by our own group and Ottenjann's group in Germany simultaneously [57,58] and by William Wolff and Hiromi Shinya in New York [59]. The importance of polypectomy in the colon as a means of preventing cancer was impressively demonstrated by Sidney Winawer and colleagues in the National Polyp Study in the USA [60].

Polypectomy significantly reduces not only the mortality from colorectal carcinomas, but also the incidence of the lesions.

Modern techniques for enlarging the endoscopic image and enhancing structures by applying stains (chromoendoscopy) are nowadays able to improve image perception and allow better classification in differentiating between surface structures that are suspicious for malignancy [61], particularly in small depressed and malignant lesions, which infiltrate the submucosa in 50% of cases. They also differ from polypoid carcinomas with regard to pathogenesis and tumor biology. The basic research carried out by Shin'ei Kudo is therefore of immense interest here [62].

Endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD). Endoscopists are nowadays undaunted by superficial and broad-based tumors, even when the lesions have already infiltrated the submucosa. Inoue and Endo [63] in Japan, as well as Soehendra's group [64] in Hamburg, can claim the merit of being the first authors to report on mucosectomy (see Chapter 30). The techniques differ, but the results are comparable. Younger endoscopists—particularly Japanese colleagues such as Yahagi—are ablating wall areas with a diameter of 10 cm or more in the esophagus, stomach, and colon using endoscopic submucosal dissection in operations lasting several hours [65]. Perforations that occasionally occur are closed by the endoscopist from inside the lumen using Endoclips, and by the laparoscopist from the serosal side. As an alternative to extensive submucosal dissection, combined laparoscopic full-thickness wall resection with endoscopic guidance is possible (see Chapter 30).

Christian Ell and his research group have recently presented a report—including what is probably the largest group of patients in the world to have received this form of treatment—impressively describing the potential of endoscopic therapy in premalignant and malignant lesions in Barrett's esophagus [66].

Drainage and endoprotheses in the bile duct. Endoscopic placement of drains in the bile duct was perfected by my former associate, Dietmar Wurbs, with an ingeniously pre-shaped probe construction [67]. Shortly afterward, Soehendra and Reynders-Frederix reported the first common bile duct stent made of plastic material [68]. These two approaches—both developed in Hamburg—for drainage of the biliary tract and pancreas have not only made ERCP, endoscopic papillotomy, and other interventions in this area safer, but have also added new indications for the treatment of biliary and pancreatic diseases to the list of indications for endoscopy. Septic cholangitis has lost its seriousness if it is treated early enough, and post-ERCP pancreatitis can be avoided more often through stenting of the pancreatic duct with a thin stent (3 Fr) made of plastic. The relevant chapters of this book describe numerous other indications for stenting through the papilla of Vater.

As in the esophagus, self-expanding metal stents are now commonplace in the palliative treatment of malignant tumors in the bile duct. Frimberger et al. can take credit for being the first to report this technique [69]. Laser therapy and radiotherapy (with the after-loading technique) for malignant stenoses [70,71] currently only have a negligible role.

Hemostasis. Massive acute hemorrhage from the upper gastrointestinal tract has presented physicians with almost insurmountable problems in every period of history [72–74]. Esophageal varices were first treated in 1939 by Crafoord and Frenkner, using sclerosing agents [75]. Sclerotherapy for esophageal varices was particularly advocated by Loren Pitcher [76], but has now been largely replaced by rubber-band ligation (“banding”) [77], a form of treatment that has long been used in the treatment of hemorrhoids. The ulcers resulting after esophageal banding are smaller and heal more quickly than the ulcers produced when sclerosants are injected. In accordance with a method originally suggested by Soehendra et al., bleeding from fundic varices can be arrested by injecting an acrylic resin [78].

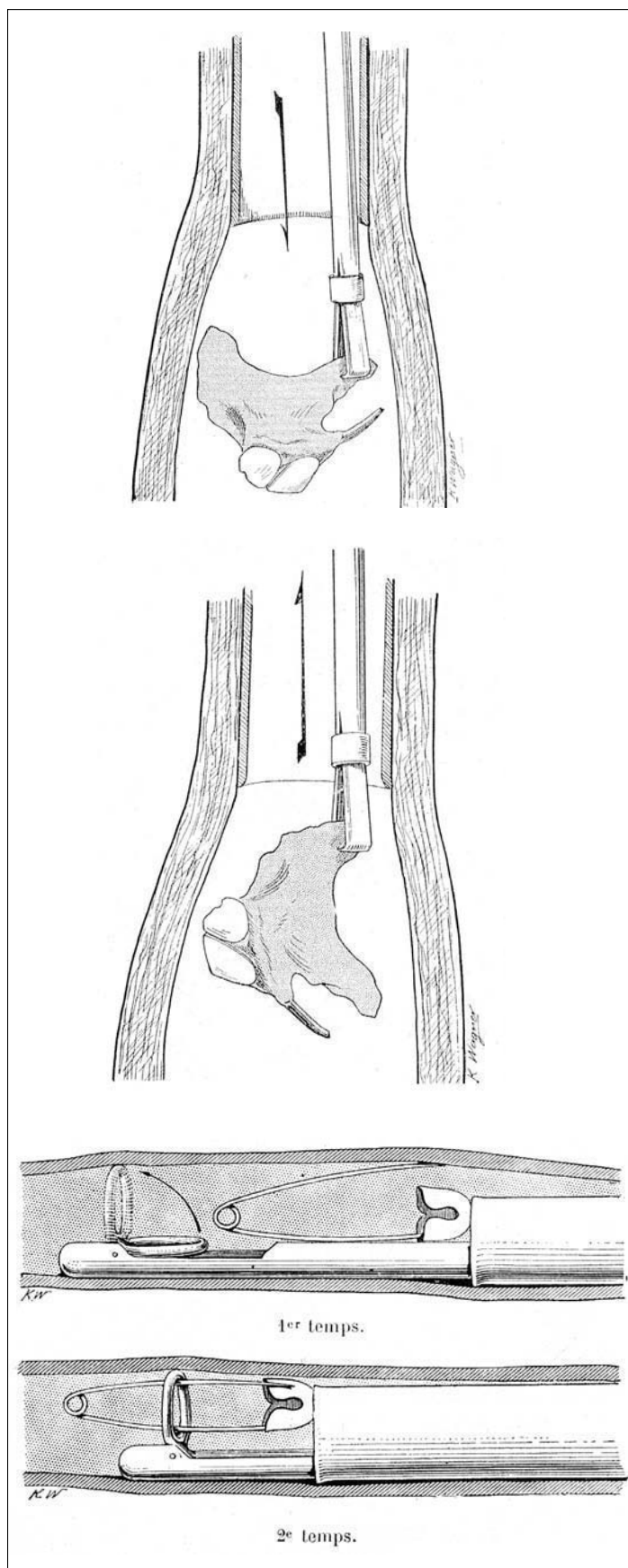


Fig. 1.14 Instructions on how to extract foreign bodies, from Jean Guisez's *Traité des maladies de l'oesophage*, 1911 [46].

The debate between the proponents of argon and Nd:YAG laser treatment for hemostasis [52,79] has long since been settled. Today, the modern argon beamer has proved its value, particularly in patients with mild bleeding and in cases of seeping hemorrhage, as well as for tissue ablation. Safe prevention or treatment of bleeding can be achieved with mechanical methods such as the Endoloop and hemoclip. The latter was already developed in the 1970s, but due to a technical problem did not gain acceptance. Experiments with endoscopic suturing machines (Heinzl, Buess) by several groups have now been resolved by Paul Swain [80,81]. The Swain model has been used to treat hiatus hernia in the context of reflux disease, and also for hemostasis.

Percutaneous endoscopic gastrostomy (PEG) was introduced by Gauderer et al. in the USA in 1980 [82]. PEG is certainly the most important method of overcoming transit disturbances for food and saliva in parts of the upper gastrointestinal tract closer to the mouth—whether the disturbances are neurogenic or caused by malignancies. If gastric dilation needs to be treated, a nutritional probe can be advanced through the gastric stoma into the jejunum. Information regarding ethical problems with PEG nutrition in patients with senile dementia and those in the terminal stages of disease is provided in Chapter 40.

Endoscopic papillotomy (EPT) and endoscopic sphincterotomy (ES, EST). Immediately after the introduction of diagnostic ERCP, the search began for a treatment approach to solve the “new diseases” for which only palliative treatment variants were available using endoscopic drainage or stenting. Even in their first approaches to the problem, Ludwig Demling and his research group started by modifying the polypectomy snare developed in Erlangen, which could be introduced without difficulty into the papilla and the ductal systems that emerge there. Electrical incision with the snare did not appear to be fully controllable endoscopically; in particular, there were concerns regarding potential trauma to the opening of the pancreatic duct, and a variant method was therefore sought. This was found in 1973 in discussions held by Ludwig Demling, particularly with Peter Frühmorgen, Hermann Bunte, and myself. Initial experiments in animals and at autopsies confirmed that the resulting instrument—known as the “Erlangen papillotome”—was practicable. It was first used in June 1973, and the procedure was successful [83]. Kawai’s research group in Kyoto pursued a different technical principle, in which an electrical knife (known as the push papillotome) is advanced into the papilla and the bile duct. Keiichi Kawai used this device in a patient for the first time in August 1973 [84]. It was subsequently found that the Erlangen papillotome was superior in terms of controllability and safety, and it is still being used throughout the world today. A miniature version of the Erlangen papillotome—which was also used for the first time by our group—may be helpful when there are anatomic variants in the ampullary orifice or in cases of stricture. The needle-knife is an important additional aid, and debate continued for several years over the indications for its use and on whether only experienced practitioners should use it or whether all endoscopists were able to do so (see Chapter 34).

Balloon dilation is an alternative to incision into the papilla of Vater, and this was first described by Staritz et al. [85]. It is now clear that anyone who carries out a dilation procedure also needs to be able to do a papillotomy.

When the length of the incision is sufficient, endoscopic papillotomy leaves a gaping common bile duct orifice and an easily recognizable pancreatic duct orifice. Endoscopists soon began to consider endoscopic treatment options for stones, parasites, inflammations, strictures, and tumors in the biliary and pancreatic ducts. Examples include mechanical lithotripsy with a reinforced Dormia basket (**Fig. 1.12**), electrohydraulic lithotripsy [86–89], laser lithotripsy [90,91], pancreatic duct stenting in chronic pancreatitis (M. Cremer), and sphincter of Oddi dyskinesia (J.E. Geenen, G. Lehman),



Fig. 1.15 Ludwig Demling.

treatment for recurrent pancreatitis in patients with pancreas divisum (P.B. Cotton), drainage [65], and bile duct stenting in patients with septic cholangitis or acute pancreatitis. As endoscopic papillotomy is a prerequisite for most endoscopic treatment methods in the bile ducts and pancreatic ductal system, it is often described as the “pattern for pancreaticobiliary procedures.”

Endoscopic Ultrasonography

The method of endoscopic ultrasonography (EUS) is undoubtedly one of the greatest advances that has been made in the field of digestive tract endoscopy, as it provides the endoscopist with unrivaled visualization of the wall of the bowel with its typical layers, as well as a glimpse of the neighboring structures. Initial experiments were conducted by Wild and Reid, who introduced a mechanically rotating scanner into the rectum in 1957 [92]. The difficulties involved in introducing a scanner into the esophagus and stomach were only solved many years later. Initial clinical experience was gained in 1980 [93–95]. The “marriage” of endoscopy and ultrasound was particularly fruitful for the staging of tumors in the upper gastrointestinal tract and pancreas. EUS using a probe in the narrow lumina of the pancreas and biliary tract is known as intraductal ultrasonography (IDUS). It provides remarkably clear images. Procedures conducted using EUS guidance—such as choledochoduodenostomy, neurolysis (e. g., of the celiac plexus) and in particular cystogastrostomy and cystoenterostomy—show the growing potential of this method [96].

Laparoscopy

In 1902, Georg Kelling (1866–1945), one of the most important personalities among the pioneers of endoscopy (including esophagoscopy and gastroscopy) inspected the abdominal cavity of a dog using a cystoscope [97,98] (**Fig. 1.16**). By 1910, he had reported a few “celioscopies” using a pneumoperitoneum and port placement. In the same year, Hans-Christen Jacobaeus in Stockholm—without knowing anything of Kelling’s work—described a procedure he called “laparoscopy” [99]. For decades, laparoscopy then played an important role, primarily in central Europe, in the morphological diagnosis of liver diseases and other conditions in the peritoneal cavity. Particular achievements in this area were made by Kalk et al. [100], Harald Lindner, and others. An outstanding atlas and textbook of laparoscopy by Henning et al. was produced by Thieme, the present publishers, in 1994 [101]. Minilaparoscopy for the diagnosis of abdominal emergencies and unclear findings in the liver and peritoneum is unfortunately nowadays only used in a few centers [102]. Ultrasound-guided biopsy of hepatic lesions appears to be replacing laparoscopy in internal medicine departments. Abdominal surgeons have relabeled laparoscopy-assisted treatment procedures as “minimally invasive surgery.” Keyhole surgery has now progressed well beyond the areas of its initial success in appendectomy and cholecystectomy [103–107], and surgery for benign gastric and intestinal diseases has now also entered the range of indications for minimally invasive procedures. Earlier warnings against carrying out oncological procedures using the laparoscope are now no longer heeded. The present volume has for the first time grouped new types of procedure under the heading of natural orifice transluminal endoscopic surgery (NOTES). Access to the abdominal organs is achieved via the body’s natural orifices (peroral, transgastric, transrectal, and transvaginal). The role of the gastroenterologist is thoughtfully outlined by Robert Hawes in Chapter 23.

Summary and Prospects

Forty years ago, endoscopy of the digestive tract only had a negligible role in the diagnosis and treatment of digestive diseases, with the exception of rectoscopy and laparoscopy. I would estimate that some 200 completely new diseases have since been discovered and correctly understood with regard to their etiology and pathogenesis, or have since become amenable to causal treatment. In most cases, this has been achieved with the help of endoscopy, biopsy, histology, radiology, microbiology, molecular biology, genetics, and other endoscopy-supported methods. The most outstanding example of this is the discovery of *Helicobacter pylori* and the diseases caused by the bacterium. Further examples of the tremendous importance of endoscopy include early recognition of gastrointestinal tumors and prevention of carcinoma in the colon using polypectomy. In comparison with other imaging methods, endoscopy is the diagnostic standard for most diseases of the digestive tract and bile ducts.

Not only has the professional profile of the gastroenterologist been fundamentally transformed, with a gastroenterologist nowadays having to be an endoscopist as well—the work of other specialists, such as radiologists, surgeons, pathologists, microbiologists, etc., has also changed drastically. Endoscopy of the upper and lower digestive tract has led to pathologists moving from the autopsy table to the sickbed. The diagnosis of endoscopic biopsies, including the latest molecular-genetic methods, is now the pathologist’s major concern, instead of the dissection of cadavers. Early advocates of this transformation included Basil Morson, Konrad Elster, Manfred Stolte, and Cyrus Rubin. Procedures that used to be surgical ones,

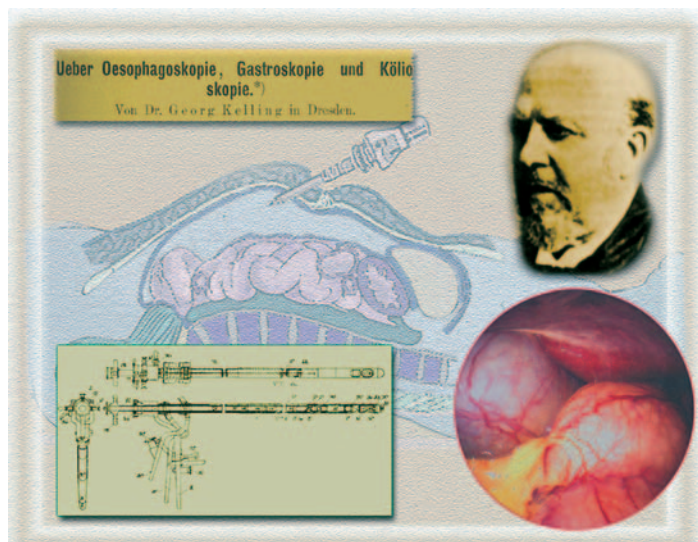


Fig. 1.16 George Kelling of Dresden and his 1902 publication.

such as choledochotomy, polypectomy, and many other interventions, have joined the range of indications for the less traumatic field of endoscopy. The most important aspect of this reallocation of territory is the outcome for the patient, which has been substantially improved. In the future, the science of endoscopy will show even more clearly than before, and in a multitude of ways, that it can produce practical and economic advantages both for patients and for health-care funding in the management of digestive and metabolic diseases. In polypectomy, stent therapy in the biliary and pancreatic ducts, drainage and endoprotheses, stricture dilation, PEG, hemostasis, and laparoscopy-assisted treatment procedures, the advantages of endoscopy are clear—even though strict scientific proof in the form of well-planned controlled clinical studies is not always available. Another example of the immense importance of endoscopy lies in early recognition of gastrointestinal tumors and carcinoma prevention in the colon using polypectomy. In the past, diseases of the bile ducts and pancreas belonged to the field of surgery, which was associated with considerable morbidity and mortality rates. ERCP, EPT, treatment for stones, dilation, stenting and drainage were the appropriate responses provided by endoscopy. These advances were of course only possible thanks to ingenious partners among the manufacturers of endoscopes and devices, such as Dr. Karl Storz, Dr. Herbert Schubert, Dr. I. Kawahara, A. Fukami, the Machida brothers, Reinhold Wappler, Don Wilson, and many others.

Developments are sure to continue at a breathtaking pace. Even now, there is nothing prophetic in suggesting that the endoscopy capsule, which has already proved its value for small-bowel diagnosis, will also become capable of retrograde movement and will be externally controllable and able to carry out therapeutic interventions. It is already possible to use biosensors on flexible endoscopes, and optical coherence tomography (OCT) is an example of this. Molecular imaging, bioendoscopy, and optical biopsy are the key words for the new endoscopic era. The next step will be to combine various types of spectroscopy with endoscopy in order to solve the problem of how to recognize neoplasia in flat areas of inflammation—as in Barrett’s esophagus or ulcerative colitis, for example. Using ingenious “beacons,” it is already possible today to use fluorescence spectroscopy to depict colonic adenomas with a diameter of 50 μm in the mouse. The future is already here. I am convinced it will be at least as exciting, fascinating, and dazzling as the last 50 years.

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2 Quality Assurance

Anthony T. R. Axon

Introduction

In recent years, quality assurance has become an integral part of health-care provision. This has arisen in response to demands from health-care purchasers, providers and staff, and more particularly as a result of increasing patient expectations.

Patients undergoing digestive endoscopy have a right to understand why the procedure is necessary, what it will entail, and what alternatives there are. They must be aware of the risks they will be taking and must be assured that the examination will be performed in an efficient and well-run department by qualified personnel with experience and a good track record. Patients expect to be treated politely and with consideration shown both to themselves and to the relatives and friends who accompany them. After the procedure, they expect the findings to be discussed with them without delay, their follow-up to be organized efficiently, and to return home safely with advice on how to seek emergency assistance if required.

Quality assurance in endoscopy is designed to ensure that examinations are carried out to the accepted current standard. If applied properly with regular auditing, this leads to continued improvement in the quality of the service provided. This is to the advantage not only of the patient, whose experience is by far the most important aspect, but also of health-care purchasers, providers, and health-care workers as well.

History of Quality Assurance

The Emperor Augustus (63 BC–14 AD) said, “I found Rome built of bricks; I leave her clothed in marble” [1]. Quality was an important concept in the ancient world. The skills employed by the Roman builders in the construction of public buildings and civil engineering can still be seen today in monuments that testify to the quality of their workmanship. Throughout the history of civilization, governments have employed inspectors to ensure that major projects were carried out to specification. In the Middle Ages, trade guilds were set up to protect both craftsmen and the public by ensuring that only those who had served an apprenticeship could become master tradesmen and charge at the appropriate rate. Nevertheless, for most articles purchased or services received, there was no guarantee and it was a case of “buyer beware.”

The Industrial Revolution led to the employment of less skilled workers in factories. In order to maintain quality standards, they worked under the supervision of a foreman. During the First World War, governments employed inspectors in the munitions factories to encourage better-quality products.

Modern quality assurance began in the USA in the 1930s, when “statistical quality control” was established on production lines. Following the Second World War, quality control was introduced into Japan by the Americans in order to help rebuild the country’s industrial base. It was this that led to quality assurance—a concept based not just on following specifications laid down by an employer, but also on taking customer feedback into account. As a result, Japanese industry flourished during the 1970s. Quality assurance expanded to encompass employee education and working conditions, when it became recognized that employee satisfaction was essential for producing high-quality products.

Quality assurance in medicine has taken longer to develop. In England, the Royal College of Physicians was established in 1517, but practitioners belonging to the College largely practiced in the upper echelons of society. The Society of Apothecaries (founded as an offshoot from the Society of Grocers in 1617) provided the medical care available to most of the population. The Company of Barber-Surgeons formed in 1540 from the union of the Fellowship of Surgeons and the Company of Barbers. This partnership remained uneasy until in 1745, the surgeons broke away and formed a separate Company of Surgeons. In 1800, the Company of Surgeons was granted a Royal Charter and became The Royal College of Surgeons in London, later of England. These organizations restricted membership of the guild or college on the basis of an individual’s educational training. During the 18th century, a visit to the “quack doctor” was also a social event (Fig. 2.1).

During the 19th and 20th centuries, medicine became scientific. Medical practitioners were obliged to obtain a license to practice, but having done so they had a free hand to practice as they wished (although their licence could be withdrawn if they practiced unethically). Specialist registration was not introduced in the United Kingdom until the 1970s. Since then, with the rapid advances in new and specialized medical, diagnostic, and therapeutic techniques, there have been radical changes in health care. Its costs have increased exponentially, medicine has become politicized, litigation has increased, and most of all patients’ expectations have soared.

In the 1970s and early 1980s, the concept of medical auditing was introduced. Medical audits were aimed at assessing outcomes such as mortality, drug expenditure, and complications of surgery. Identifying the reasons why mortality or complications occurred, or why drug expenditure was high, made it possible to establish guidelines to rectify problems. The auditing loop was closed by repeating the audit at a later date and if necessary modifying the guidelines in the light of the new audit.



Fig. 2.1 Quality assurance in medicine. William Hogarth (1697–1764), *Marriage à la Mode*, 3: *The Inspection*, also known as *The Visit to the Quack Doctor* (ca. 1743; © The National Gallery, London).

Auditing drew attention to the variability of medical practice between one institution and another. A highly publicized investigation into excessive mortality in children undergoing heart surgery at Bristol Royal Infirmary in England during the years 1983–1995 revealed that no mechanisms were in place to identify problems automatically. These concerns, allied with the rapidly increasing cost of health care, led health contractors and patients to demand reassurance about the effectiveness of interventions and the standard of care. It became apparent that the only way to prevent inadequate practice was to introduce some form of quality assurance.

Quality Assurance in Endoscopy

Quality assurance involves setting a standard of care and ensuring that it is maintained. Health care can be divided into the elements of structure, process, and outcome [2]. In the case of endoscopy, examples of structure would include the endoscopy unit, equipment, and staff; the process would be the actual endoscopic procedure; and the outcome would be the change in health status resulting from the endoscopic procedure. Quality assurance therefore needs to address all three aspects; good structure will increase the likelihood of a good process, and a good process the likelihood of a good outcome. It is essential to place the patient at the center of quality assurance. This involves assessment and quantification of the clinical quality of the procedure provided for the patient, and also the quality of the patient's experience itself.

The next step is to consider what to measure when assessing quality. "Indicators" known to reflect the quality of care are required. Once these have been identified, a minimum standard can be set and performance can be measured against it. Failure to reach such a standard would demonstrate a poor quality of care and would result in action being taken to improve practice [3].

■ Quality Indicators

The measurement of quality in endoscopy has been addressed in detail by a working party of the American Society of Gastrointestinal Endoscopy (ASGE) and the American College of Gastroenterology [4]. The resulting recommendations are available free of charge on the ASGE web site (www.asge.org). The task force produced a comprehensive and practical approach to quality indicators. The report includes a general introduction applicable to all gastrointestinal endoscopic procedures and then deals individually with esophago-gastroduodenoscopy, colonoscopy, endoscopic retrograde cholangiopancreatography (ERCP), and endoscopic ultrasonography. Recommendations are graded according to the quality of evidence in the literature that supports the various recommendations—ranging at best from grade 1A, where there is a clear benefit supported by randomized trials without important limitations and leading to a strong recommendation that can be applied to most clinical settings; down to grade 3, where the clarity of benefit is unclear, the evidence is based on expert opinion only, and the implication of the recommendation is weak and likely to change as further data become available.

Table 2.1 Preprocedural quality indicators

- Patient demographics
- Indication
- Timeliness
- Consent
- Clinical status and risk assessment
- Special precautions
- Sedation plan
- Team pause ("time out")

■ Preprocedural Quality Indicators

Quality indicators in digestive endoscopy can be broadly divided into three aspects: preprocedural, intraprocedural, and postprocedural. **Table 2.1** sets out the general preprocedural quality indicators based on the recommendations made by the American working party. Most of these indicators form part of the written endoscopy report.

Indication for Endoscopy

The indication for the procedure must be stated. An endoscopic examination will generally be undertaken only if the potential findings are likely to influence the management of the patient. Endoscopy is contraindicated when the risks of the procedure outweigh its potential benefit, or when the patient, having been fully informed of the advantages and disadvantages of the procedure, decides against having it done. There is a gray area in which the benefits of endoscopy are marginal, or when the cost or inconvenience of the procedure may outweigh the benefit. A number of authorities have made recommendations regarding which clinical situations merit endoscopy and which do not [5,6], but it is not unusual for significant pathology to be identified in a proportion of patients who would fall into the "inappropriate" group [7–9]. National guidelines on indications cannot necessarily be applied in other countries, as the epidemiology of diseases, the facilities available, and prosperity vary from country to country.

Timeliness

The timeliness of the procedure is of importance; patients usually expect a diagnosis without delay. Timeliness must be judged in relation to the indication—for example, a patient presenting with melena will require a more urgent endoscopy than one with dyspeptic pain.

Informed Consent

The issue of informed consent has assumed considerable importance in recent years [10]. Patients in most developed countries today expect to receive a full explanation as to why they require an endoscopy, what it will involve, how much it will cost, the risks it will entail, and how complications would be managed. They should also be aware of what alternative investigations could be used and when the procedure can be carried out. Each patient should receive an easily understood information sheet to take home. Ideally, unless it is an emergency procedure, the patient should sign the consent form at a later date, after they have had time to reflect and if necessary discuss it with friends, relations, or other professionals. The form should not be signed in the endoscopy suite just before the procedure takes place.

Preliminary Assessment

Before the endoscopy procedure, the patient's health status should be assessed, the American Society of Anesthesiology (ASA) score should be recorded (**Table 2.2**), and any potential risks should be noted—for example, whether antibiotic prophylaxis is needed or whether advice should be given to the examiner regarding the patient's anticoagulation treatment or diabetes. Special precautions may be needed, such as avoidance of latex rubber gloves. The

patient may have drug allergies, or in those with sleep apnea it may be necessary to have an anesthetist in attendance. A sedation plan should be drawn up and discussed with the patient so that he or she is aware of what will take place.

Team Pause

The American guidelines suggest that before sedation is administered or the endoscope is inserted, a pause should be observed and documented, during which the team are clear that they have the correct patient and that the appropriate procedure will be done, and to reassess any other data that might influence the endoscopy procedure.

Intraprocedural Quality Indicators

Table 2.3 shows the intraprocedural quality indicators for EGD. Quality indicators vary according to which procedure is being performed.

Monitoring

All patients require monitoring of some kind. For those receiving sedation, intravenous access is essential, pulse oximetry and oxygen saturation is now standard, and most units monitor blood pressure. Electrocardiography may be necessary in certain patients.

Drugs and Sedation

Any medication given must be documented. It is helpful for the nursing staff to record the degree of sedation and any discomfort experienced by the patient or lack of cooperation. These data can be linked to the amount of sedation given to the patient and may lead to the conclusion that an endoscopist is either using too much or too little sedation, or possibly the endoscopic technique requires improvement.

Recordings

A photographic record of the procedure should be made. In some units, a video of the examination is retained. The timing of the procedure is valuable, particularly in colonoscopy, where the time taken to reach the cecum may provide some assessment of the examiner's endoscopic skill, whilst—perhaps more importantly—the time to extubation, if not long enough, may lead to a smaller harvest of polyps.

Postprocedural Quality Indicators

Table 2.4 sets out the quality indicators for the postprocedural period.

Discharge Criteria

An in-house protocol should be in place setting out the discharge criteria for patients. These should be documented at discharge, and the patient should be provided with written instructions as to what to do in the immediate post-discharge period. The patient must be

Table 2.2 American Society of Anesthesiology (ASA) score

| Class | Findings |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I | Healthy patients |
| II | Mild systemic disease, no functional limitations, no acute problems (e.g., controlled hypertension, mild diabetes) |
| III | Severe systemic disease, definite functional limitation (e.g., brittle diabetic, frequent angina, myocardial infarction) |
| IV | Severe systemic disease with acute, unstable symptoms (e.g., myocardial infarction within last 3 months, congestive heart failure, acute renal failure, uncontrolled active asthma) |
| V | Severe systemic disease with imminent risk of death |

Table 2.3 Intraprocedural quality indicators recorded for esophagogastroduodenoscopy

- Instruments
- Monitoring
- Medication
- Completeness of examination
- Location of Z line
- Findings
- Photographic record
- Procedure time
- Patient discomfort
- Endoscopic therapy given
- Outcome
- Biopsies taken
- Complications

Table 2.4 Postprocedural quality indicators

- Predetermined discharge criteria
- Written instructions for patient
- Pathology results
- Follow-up
- Report
- Complications
- Patient satisfaction
- Communication with referring clinician
- Postprocedural drug treatment

informed about the follow-up arrangements and when pathology results will become available.

The Report

The endoscopy report is the most important part of the quality assurance exercise, as it contains most of the information that will be required for analysis. It should include the patient's name and demographic details, the name of the referring clinician, and the indication for the procedure. The patient's ASA grade should be recorded, together with the nature and amount of sedation given and the instrument used for the examination. Any peculiarities or difficulties experienced in the procedure should be noted. In the case of colonoscopy, the quality of bowel preparation should be indicated. Then the extent of the procedure should be described—for example, whether the cecum was reached or the ileum. Any abnormalities identified should be described, along with the procedures undertaken—specifically, whether biopsies were taken and if so, from where and what number. Complications are recorded, as well as the use of any additional sedation or reversal agents.

Specific quality indicators collected by the nursing staff, such as the degree of sedation, discomfort, and pre-assessment and post-

Table 2.5 Intraprocedural quality indicators for endoscopic retrograde cholangiopancreatography (ERCP; in addition to those given in Table 2.2)

- Assessment of procedural difficulty
- Cannulation success
- Use of precut
- Size and number of biliary stones
- Stone clearance success
- Extraction technique used
- Stent placement
- Clinical success rate

Table 2.6 Intraprocedural quality indicators in colonoscopy (in addition to those given in Table 2.2)

- Quality of bowel preparation
- Cecal intubation
- Small-bowel intubation
- Number of polyps detected
- Number of polyps retrieved
- Size of polyps
- Time to cecum
- Withdrawal time

assessment details should be recorded separately by nursing staff and included in the computerized report.

Discharge

A letter should be despatched to the referring clinician indicating the findings of the endoscopy. The staff responsible for discharging the patient must be certain that the patient is fully apprised of any change in medication that is to take place after the endoscopy, such as restarting anticoagulant treatment. Patients should be provided with an emergency phone number, so that if there are any problems they can access medical advice after leaving the endoscopy unit.

Patient Satisfaction

Information should be gathered about patient satisfaction. This is usually done by encouraging patients to complete a questionnaire. The number of patients who respond is limited, and it is difficult to know how much confidence can be attached to these results. There are similar issues with late complications. Prospective studies identify more complications than those obtained retrospectively or by questionnaire. Inability to record accurately patients' views and any complications that occur is a serious drawback in assessing patient satisfaction.

It is beyond the scope of this chapter to discuss in detail all of the quality indicators for each type of procedure, but suggested intraprocedural indicators for ERCP and colonoscopy are listed in **Tables 2.5** and **2.6**, and the American guidelines mentioned above can be consulted.

Nursing Involvement in Quality Assurance

Quality assurance is a team activity. It involves the director of the endoscopy unit, the nurse in charge, the nursing staff, the hospital administration, secretarial and reception staff, and those responsible for cleaning and maintenance of the department. However, documentation of the quality indicators rests mainly with the medical and nursing staff, who are largely responsible for the prelimi-

nary assessment, intraprocedural monitoring, and postprocedural assessment.

Other areas besides the procedure itself require quality control. These include tracking of the equipment used, cleaning and disinfection of endoscopic equipment, and auditing of these processes. Ordering of equipment and inventory maintenance are necessary for the smooth and efficient running of an endoscopy unit.

Staff Safety and Satisfaction

Staff safety, efficient and personalized rostering, the provision of changing facilities, showers, and access to refreshment all encourage a happy working environment. Nursing staff often regard the quality of their working time and in particular their hours of work and scheduling as more important than the level of their salary, so it is incumbent upon those in charge of endoscopy units to ensure that working conditions are as good as they possibly can be in order to retain experienced staff and thereby provide a better-quality service.

How Should Quality Indicators Be Recorded?

Most of the quality indicators discussed above will be recorded routinely in the endoscopy report. For the purposes of quality assurance, however, it is essential that all relevant quality indicators for a particular procedure should be included.

In colonoscopy, the quality of the bowel preparation, the amount of sedation given, the colonoscopist's expertise, the time spent reaching the cecum and during withdrawal, the number of polyps identified, and instruments used are all interrelated. If these comprehensive data are not available and cannot be analyzed, the cause of a poor outcome by an endoscopist or by an endoscopy unit cannot be identified.

The incidence of bleeding, perforation, and pancreatitis in ERCP may be related to the skill of the operator, the time taken to do the procedure, the patient's age, gender, and indication, and the use of the needle precut technique. Unless all of these indicators can be analyzed, the reason why an individual examiner has a higher incidence of postprocedural pancreatitis may not be apparent. The purpose of continued quality improvement is to identify areas in which individual endoscopists or units can improve their outcomes, so complete data collection is necessary and the ability to analyze the data is critical.

Quality Assurance and Information Technology

Many endoscopists still complete their examination reports by dictation or freehand rather than using a computerized reporting system. This means that quality indicators are often not fully recorded and manual retrospective analysis is required for quality assurance.

The advantage of a computerized system is that software can be created that insists on quality indicators being entered. Further development of the software enables comparisons to be made between oxygen desaturation, the amount of sedation, and successful cecal intubation, for example. At present, the major drawback with quality assurance is the absence of commercially available software systems that are able to record and analyze the relevant data in the way indicated above. Some argue that the use of computerized endoscopic reporting seriously prolongs the time taken to complete the report. This is certainly true of a number of software systems that have been developed. However, the better-designed

ones can be used with considerable speed once the endoscopist has completed the learning curve.

There is a need for better and more readily available systems using generally accepted terminology, such as the Minimal Standard Terminology published by the World Organization of Digestive Endoscopy/*Organisation Mondiale d'Endoscopie Digestive* (OMED) [11]. A further advantage of a computerized system is that it provides a typed (and therefore legible) report that is immediately available for despatch to referring clinicians or the patients themselves. A computer-generated report saves secretarial time and storage space and allows immediate access to previous endoscopy reports.

For individuals and departments without access to computerized reporting, quality assurance is limited to retrospective analysis of written or typed reports, or specific prospective audits undertaken as a separate exercise, which is often incomplete and subjective.

A simple example of the colonoscopy success rate obtained from eight colonoscopists working in a department in England over a 3-month period is shown in **Fig. 2.2**. Similar data can be extrapolated in graphic form showing the ASA grades of the patients examined, the number of polyps identified, and the average dose of sedation used [12].

■ How Should Quality Assurance Data Be Used?

Quality Standards

The aim of quality assurance is to ensure that patients receive a high standard of care within the endoscopy unit. For this to be possible, it is necessary to set certain quality standards. For example, a department, a health-care provider, or a national endoscopy society might recommend that endoscopists should be able to perform total colonoscopy 90% of the time and that they should be able to retrieve at least one tubular adenoma from at least 15% of the examinations that they undertake. By monitoring the endoscopists in a unit using the techniques outlined above, it would become apparent which endoscopists were not reaching the prescribed quality level. This would lead to an analysis of that endoscopist's data to see whether, for example, he or she was not spending sufficient time trying to reach the cecum, whether the patient mix was different or the patients were less well prepared, older, or less healthy, or whether insufficient sedation was being used. Remedial action could then be taken, which might involve the endoscopist concerned having a period of performing endoscopy under supervision.

Quality assurance should not be threatening. The data in **Fig. 2.2** are anonymized and were sent to all eight colonoscopists, each of whom knew his or her own number but was not able to identify the others. All of the numbers were known to the quality assurance supervisor, an experienced colonoscopist who was able to take individual action if it became necessary. The availability of these data, circulated by e-mail, enabled those who were less successful to identify where their examinations were falling short.

Trainees

Routine prospective collection of data is helpful in assessing the progress of trainees. The use of this technology allows more objective assessment of the trainees' success, which is a better method of determining competence than assessing it on the basis of the number of procedures performed or one or two endoscopies carried out under supervision.

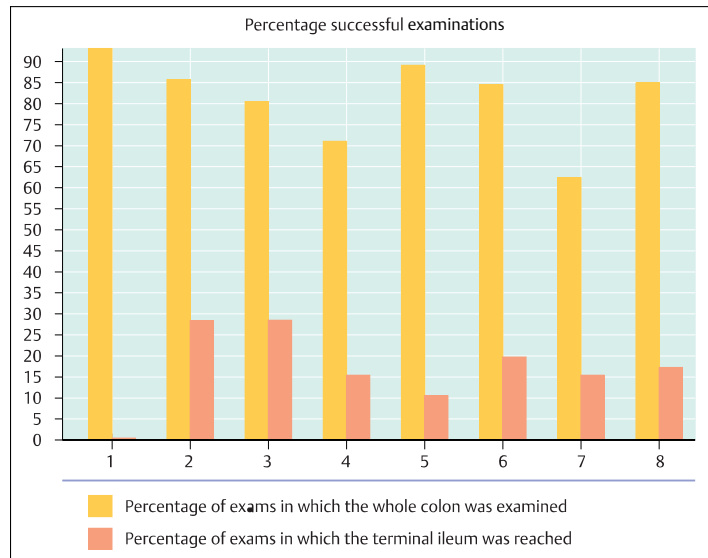


Fig. 2.2 Success for total colonoscopy (%).

Continuous Quality Improvement

Quality assurance should not be used to provide only a minimum quality of treatment. When applied correctly, it should engender continuous improvement in quality, and this can be done only by frequent monitoring of quality indicators, with regular assessment as to how the quality can be improved. This should be applied across the whole range of the service being provided and include waiting times, scheduling, cost management, efficiency in the endoscopy unit, and staff satisfaction, in addition to improving technical success rates and clinical outcomes. In the United Kingdom, this approach has been introduced into the National Health Service using the endoscopy Global Rating Scale (GRS).

The Endoscopy Global Rating Scale

Total control of medicine by the government (“socialized medicine”) medicine enables government to introduce quality regulations and insist that they be followed. In the United Kingdom, the Department of Health has introduced a web-based questionnaire that all National Health Service endoscopy units are expected to complete [13]. It is divided into two separate dimensions: clinical quality and quality of patient experience. Each of these two dimensions includes 12 patient-centered items (**Table 2.7**). Each of the 24 items in turn has a series of statements to which the endoscopy director has to answer “yes” or “no” online. On the basis of these replies, the Department of Health is able to derive a global rating score, the lowest level being D and the highest A. Since its inception, the percentage of units scoring A or B has increased. To achieve a high rating means that there has to be continuous monitoring of a variety

Table 2.7 The twelve patient-centered standards used in the United Kingdom Global Rating Scale for endoscopy

| Clinical quality | Quality of patient experience |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> ● Appropriateness ● Information/consent ● Safety ● Comfort ● Quality ● Timely results | <ul style="list-style-type: none"> ● Equality ● Timeliness ● Choice ● Privacy and dignity ● Aftercare ● Ability to provide feedback |

Source: www.grs.nhs.uk.

of quality indicators, with an achievement of a colonoscopy completion rate of over 90 %, and an adenoma detection rate of over 10 %, with a polyp recovery rate of more than 90 %. Sedation and analgesia, comfort levels, good-quality bowel preparation, and continuous monitoring for complications have to be performed. Further details, together with a list of quality and safety indications for endoscopy, are available on the GRS web site (www.grs.nhs.uk).

Impact of Quality Assurance on Endoscopic Practice

The introduction of quality assurance undoubtedly increases the workload not just for the endoscopist, but for most of the team working in the endoscopy unit and in particular the chief nurse and endoscopy director. Continuous monitoring and regular auditing increases the cost of running the endoscopy unit, and in addition will identify defective equipment requiring replacement. Examinations take longer if the endoscopist adheres to recommended standards—for example, it takes longer to obtain informed consent, and the extubation time at endoscopy may have to be increased to maximize the number of polyps identified.

Quality assurance also covers efficiency in the endoscopy unit and should lead to more appropriate scheduling, a reduction in the numbers of unnecessary endoscopies performed, and more efficient methods of reducing turnaround time. Improved patient satisfaction should lead to fewer complaints and a reduction in litigation. The most important outcome should be an improvement in the clinical effectiveness of endoscopy [14,15], fewer complications, more satisfied patients, and improved conditions for staff, leading to a higher rate of staff retention, better morale, and pride in the service being provided.

What Are the Next Steps?

The principles underlying quality assurance in endoscopy are now firmly established. There is general agreement on which quality indicators should be recorded. To date, however, there is no universal consensus regarding the level of quality that should be achieved. National and international organizations are beginning to appreciate that it is necessary to set certain standards that will have to be reached if an individual endoscopist is to remain in practice or if a department is to continue to provide a service. We can expect to see the introduction of specific parameters within the next few years.

Standards will be set on the basis of what is considered to be good practice. Provided that individual endoscopists are competently trained and that they continue to perform a sufficient number of procedures on a regular basis and attend courses in professional development, there should be little difficulty in maintaining an acceptable endoscopic standard. No doctor enjoys practicing sub-optimally. Among those who practice within accepted guidelines, the risk of litigation will fall. Refresher courses will be required for those who would benefit from them.

Managing the Endoscopy Unit

It is becoming recognized that specific skills and training are required for individuals who manage endoscopic services. OMED initiated a series of Endoscopy Directors' Workshops in 2005 in order to improve the standard of endoscopy worldwide. Many aspects of the workshops are concerned with quality in one way or another, but an important section is specifically designed to discuss quality assurance in the endoscopy unit. A group within the ASGE is also hoping to set up a section within the society to address issues relating to endoscopy unit management [16]. These workshops and meetings have identified important areas of management not previously addressed by health-care providers or by national societies. A major deficiency is the inadequate provision of information technology in endoscopy. Although some organizations have attempted to stimulate industry to take an interest in this area, the products created have not fulfilled requirements. Considerable work is needed in this area.

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