Practical Gastrointestinal Endoscopy

The Fundamentals

Practical Gastrointestinal Endoscopy

The Fundamentals

Peter B Cotton
MD FRCP FRCS
with the assistance of Robert H Hawes and colleagues
Digestive Disease Center
Medical University of South Carolina
Charleston, South Carolina, USA

Christopher B Williams
BM FRCP, FRCS
with the assistance of Brian P Saunders and colleagues
Wolfson Unit for Endoscopy
St Mark's Hospital for Colorectal and Intestinal Disorders
Harrow, London, UK

with the assistance of

Robert H Hawes
MD
Digestive Disease Center
Medical University of South Carolina
Charleston, South Carolina, USA

Brian P Saunders
MD
Wolfson Unit for Endoscopy
St Mark's Hospital for Colorectal and Intestinal Disorders
Harrow, London, UK

SIXTH EDITION

WILEY-BLACKWELL
A John Wiley & Sons, Ltd., Publication

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing program has been merged with Wiley's global Scientific, Technical and Medical business to form Wiley-Blackwell.

Registered office: John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

Editorial offices: 9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
111 River Street, Hoboken, NJ 07030-5774, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell

Library of Congress Cataloguing-in-Publication Data
Practical gastrointestinal endoscopy : the fundamentals / Peter B. Cotton ... [et al.]. -- 6th ed.
p. ; cm.
Rev. ed. of: Practical gastrointestinal endoscopy : the fundamentals / Peter B. Cotton, Christopher B. Williams. 5th ed. c2003.
Includes bibliographical references and index.
ISBN 978-1-4051-5902-9 (alk. paper)
1. Gastroscopy. I. Cotton, Peter B. II. Cotton, Peter B. Practical gastrointestinal endoscopy.
[DNLM: 1. Gastrointestinal Diseases--diagnosis. 2. Endoscopy. WI 141 P8947 2008]

RC804.G3C68 2008
616.3'307545--dc22

2007050629

ISBN: 978-1-4051-5902-9

A catalogue record for this book is available from the British Library.

Set in 9/12 pt Palatino by Sparks, Oxford – www.sparkspublishing.com
Printed in Singapore by Markono Print Media Pte Ltd

First published 1980
Second edition 1982
Third edition 1990
Fourth edition 1996
Fifth edition 2003
Sixth edition 2008

1 2008

Contents

Preface to the Sixth Edition

The investigation and management of patients with digestive problems was revolutionized in the 1960s with the introduction of flexible endoscopes, based on fiberoptic light transmission. Their diagnostic potential became obvious with improved visualization, increased tip control and biopsy capability. Subsequent developments, such as video-endoscopy, and the proliferation of therapeutic applications moved endoscopy into the mainstream of gastroenterology, and fueled its enormous expansion worldwide.

The field continues to expand in many ways. The endoscopy capsule has found a clinical role, and some intrepid endoscopists are expanding their therapeutic horizons with techniques like endoscopic mucosal resection (EMR and ESD), fundoplication, and trans-gastric procedures. The marriage between endoscopy and computing will produce more magical new tools, such as computer simulation for teaching and assessment of competence.

The success of endoscopy means that it has now become a very serious business, which requires careful attention to many details. We must all strive to provide needed services of the best possible quality.

Twenty-five years ago it was possible to encapsulate most of what endoscopists needed to learn in a single book, such as our popular text *Practical Gastrointestinal Endoscopy*. After four editions we decided to break off the more complex aspects such as endoscopic retrograde cholangio-pancreatography (ERCP), endoscopic ultrasound (EUS), and endoscopy unit management. These are addressed in a series of “Advanced endoscopy ebooks” in print and on line at www.gastrohep.com.

The goal of this short book is to provide a guide to the fundamentals of endoscopic practice, focusing on the common standard procedures (uppers and colons, and their therapeutic applications), and concentrating on the facts that may be useful to those in their first years of experience.

We are delighted to be joined in this endeavor by two distinguished co-authors, Robert Hawes and Brian Saunders. Their wisdom comes from deep in the trenches of daily practice.

Peter B. Cotton
Christopher B. Williams

Acknowledgments

Peter Cotton dedicates his efforts to Marion and our family, and gratefully acknowledges advice and help from many colleagues and friends who have reviewed and improved parts of the manuscript. These include Bhin Pham, Mark Delegge, John Vargo, Marcello Vela, Alistair Cowen, Di Jones, and Phyllis Malpas.

Christopher Williams similarly acknowledges the longstanding patience of Dr Christina Williams, and feedback from colleagues at St Mark's Hospital, London, notably his successor Dr Brian Saunders—re-energizing the academic and colonoscopy training activities of the 'Wolfson Unit for Endscopy' www.wolfsonendoscopy.org.uk.

1 The Endoscopy Unit and Staff

Most endoscopists, and especially beginners, focus on the individual procedures and have little appreciation of the extensive infrastructure that is now necessary for efficient and safe activity. Endoscopy has become a sophisticated industry. Many of us work in large units with multiple procedure rooms full of complex electronic equipment, with additional space dedicated to preparation, recovery, and reporting, in collaboration with teams of specially trained nurses and support staff. More and more units resemble operating room suites, but with a human touch. Endoscopists are also learning (often painfully) some of the imperatives of surgical practice, such as efficient scheduling, disinfection, and safe sedation/anesthesia.

Endoscopy is a team activity, requiring the collaborative talents of many people with different backgrounds and training. It is difficult to overstate the importance of appropriate facilities and adequate professional support staff, in order to maintain patient comfort and safety, and to optimize clinical outcomes.

Staff

Specially trained endoscopy nurses have many important functions:

- They prepare patients for their procedures, physically and mentally.
- They set up all of the necessary equipment.
- They assist endoscopists during procedures.
- They monitor patients' safety, sedation and recovery.
- They clean, disinfect, and process equipment.
- They maintain quality control.

Technicians and nursing aides may contribute to these functions. Large units need a variety of other staff, to handle reception, transport, reporting, and equipment management.

Facilities

The modern endoscopy unit has areas designed for many different functions. Like a hotel or an airport (or a Victorian household), the endoscopy unit should have a smart public face ("upstairs"), and a more functional back hall ("downstairs"). From the patient's perspective, the endoscopy suite consists of areas devoted to reception, preparation, procedure, recovery, and discharge. Supporting these activities are other functions, which include scheduling, cleaning, preparation, maintenance and storage of equipment, reporting and archiving, and staff management.

Procedure rooms

The rooms used for endoscopy procedures have certain key requirements:
• They should not be cluttered or intimidating. Most patients are not sedated when they enter, so it is better for the room to resemble a modern kitchen rather than an operating room.
• They should be large enough to allow a patient stretcher trolley to be rotated on its axis, and to accommodate all of the equipment and staff (and any emergency team), but also compact enough for efficient function.
• They should be laid out with the specific functions in mind, keeping nursing and doctor spheres of activity separate (Fig. 1.1), and minimizing exposed trailing electrical cables and pipes.

Each room should have:
• piped oxygen and suction (two lines);
• lighting that is focused for nursing activities, but not dazzling to the patient or endoscopist;
• video monitors (for the endoscopy image and monitoring outputs) placed conveniently for the endoscopist and assistants, and allowing the patient to view, if wished;
• adequate counter space for accessories, and a large sink for dirty equipment;

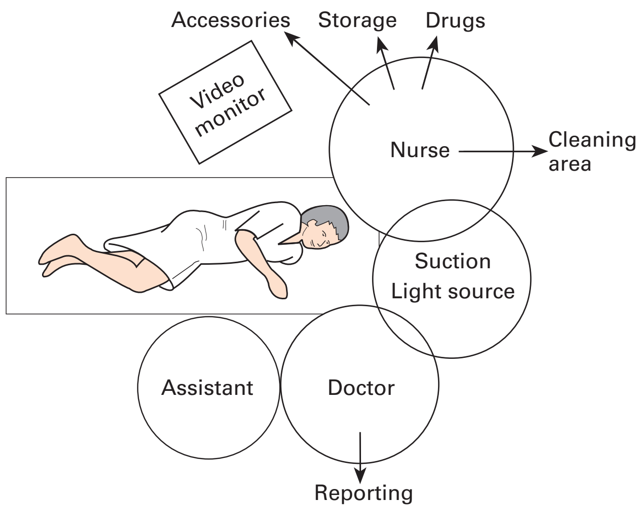

Fig. 1.1 Functional planning—spheres of activity.

• storage space for the equipment required on a daily basis;
• systems of communication with the charge nurse desk, and emergency call;
• disposal systems for hazardous materials.

Peri-procedure areas

The peri-procedure areas that patients encounter include:
• reception and waiting rooms for patients and accompanying persons;
• preparation areas (for safety checking, consent, undressing, intravenous (IV) access);
• recovery bays or rooms. These should be separate from the preparation area, so that patients coming in are not mixed with those going out (for obvious reasons), but adjacent for efficient nursing management;
• postprocedure interview and discharge rooms. A private room must be available for sensitive consultations.

Staff areas

The endoscopy unit also has many support areas that patients do not see, including:
• a central focus workstation—this is needed in any unit that has three or more endoscopy rooms. Like the bridge of a ship, it is where the nurse captain of the day controls and steers the whole operation;
• endoscope storage, cleaning, and disinfection areas;
• areas for storage of all other equipment, including an emergency cart;
• medication storage;
• reporting room;
• management office;
• storage for staff valuables; and
• staff refreshment area.

Management and behavior

Complex organizations require efficient management and leadership. This works best as a collaborative exercise between the medical director of endoscopy and the chief nurse or endoscopy nurse manager. The biggest units will also have a separate administrator. These individuals must be skilled in handling people (doctors, staff, and patients), complex equipment, and significant financial resources. They must develop and maintain good working relationships with many departments within the hospital (such as radiology, pathology, sterile processing, anesthesia, bioengineering), as well as numerous manufacturers and vendors. They also need to be fully cognizant of all of the many local and national regulations which now impact on endoscopy practice.

The wise endoscopist will embrace the team approach, and realize that maintaining an atmosphere of collegiality and mutual respect is essential for efficiency, job satisfaction, and staff retention, and for optimal patient outcomes.

It is also essential to ensure that the push for efficiency does not drive out humanity. Patients should not be packaged as mere commodities during the endoscopy process. Treating our customers (and those who accompany them) with respect and courtesy is fundamental. Always assume that patients are listening, even if apparently sedated, so never chatter about irrelevances in their presence. Never eat or drink in patient areas. Background music is appreciated by many patients and staff.

Documentation

Information for patients (such as explanatory brochures and maps) is discussed in Chapter 3 (see "Patient education and consent").

The agreed policies of the unit (including regulations dictated by the hospital and national organizations) are enshrined in an Endoscopy Unit Procedure Manual (Fig. 1.2). This must be easily available, constantly updated, and frequently consulted.

Day-to-day documentation includes details of staff and room usage, disinfection processes, instrument and accessory use and problems, as well as the procedure reports.

Procedure reports

Usually, two reports are generated for each procedure—one by the nurses and one by the endoscopist.

Nurse's report

The nurse's report usually takes the form of a preprinted "flow sheet," with places to record all of the preprocedure safety checks, vital signs, use of sedation/analgesia and other medications, monitoring of vital signs and patient responses, equipment and accessory usage, and image documentation. It concludes with a copy of the discharge instructions given to the patient.

Fig. 1.2 Endoscopy unit practices are collected in a procedure manual.

Endoscopist's report

The endoscopist's report includes the patient's demographics, reasons for the procedure (indications), specific medical risks and precautions, sedation/analgesia, findings, diagnostic specimens, treatments, conclusions, follow-up plans, and any unplanned events (complications). Endoscopists use many reporting methods—handwritten notes, preprinted forms, free dictation, and computer databases.

The paperless endoscopy unit

Eventually all of the documentation (nursing, administrative, and endoscopic) will be incorporated into a comprehensive electronic management system. Such a system will substantially reduce the paperwork burden, and increase both efficiency and quality control.

Educational resources

Endoscopy units should offer educational resources for all of its users, including patients, staff, and doctors. Clinical staff need a selection of relevant books, atlases, key reprints, and journals, and publications of professional societies. Increasingly, many of these materials are available on-line, so that easy internet access should be available. Many organizations produce useful educational videotapes, CD-ROMs, and DVDs. In the future, some of these resources will be linked directly with endoscopy reporting systems.

Teaching units will need to embrace computer simulators, which are becoming valuable tools for training (and credentialing). Patients are also increasingly interested and well served with educational materials. Details are given in Chapter 8.

Further reading

American Gastroenterological Association. AGA Standards for office-based gastrointestinal endoscopy services. *Gastroenterology* 2001; **121**: 440–43.

American Society for Gastrointestinal Endoscopy. Establishment of gastrointestinal areas. *Gastrointest Endosc* 1999; **50**: 910–12.

Cotton PB, Barkun A, Hawes RH, Ginsberg G (eds) *Efficiency in Endoscopy. Gastrointestinal Endoscopy Clinics of North America*, Vol. 14(4) (series ed. Lightdale CJ). Philadelphia: WB Saunders, 2004.

Frakes JT (ed.) *Ambulatory Endoscopy Centers. Gastrointestinal Endoscopy Clinics of North America*, Vol. 12(2) (series ed. Lightdale CJ). Philadelphia: WB Saunders, 2002.

Petersen B, Ott B. Design and management of gastrointestinal endoscopy units. In: *Advanced Digestive Endoscopy e-book/annual; Endoscopic Practice and Safety.* Blackwell Publications, www.gastroHep.com.

Quine MA, Bell GD, McCloy RF, Charlton JE, Devlin HB, Hopkins A. Prospective audit of upper gastrointestinal endoscopy in two regions of England; safety and staffing, and sedation methods. *Gut* 1995; 462–67.

Shephard M, Mason J (eds) *Practical Endoscopy.* London: Chapman & Hall, 1997.

Sivak MV, Manoy R, Rich ME. The endoscopy unit. In: Sivak MV (ed.) *Gastroenterologic Endoscopy*, Vols 1 and 2, Philadelphia: WB Saunders, 2000.

Zuccaro G Jr, Vargo JJ (eds) *Sedation and Management in Gastrointestinal Endoscopy. Gastrointestinal Endoscopy Clinics of North America*, Vol. 14(2) (series ed. Lightdale CJ). Philadelphia: WB Saunders, 2004.

Endoscopic Equipment

2

Endoscopes

There are many different endoscopes available for various applications, but they all have common features. There is a control head with valves (buttons) for air insufflation and suction, a flexible shaft (insertion tube) carrying the light guide and one or more service channels, and a maneuverable bending section at the tip. An umbilical or universal cord (also called "light guide connecting tube") connects the endoscope to the light source and processor, air supply, and suction (Fig. 2.1).

The image is captured with a CCD (charge-coupled device) chip, transmitted electronically, and displayed on a video monitor. Individual photo cells (pixels) in the CCD chips can respond only to degrees of light and dark. Color appreciation is arranged by two methods. So-called "color CCDs" have their pixels arranged under a series of color filter stripes (Fig. 2.2). By contrast, "monochrome CCDs" (or, more correctly, sequential system CCDs) use a rotating color filter wheel to illuminate all of the pixels with primary color strobe-effect lighting (Fig. 2.3). This type of chip can be made smaller, or can give higher resolution, but the system is more expensive because of the additional mechanics and image-processing technology.

Illumination is provided from an external high-intensity source through one or more light-carrying fiber bundles.

Tip control

The distal bending section (10 cm or so) and tip of the endoscope is fully deflectable, usually in both planes, up to 180° or more. Control depends upon pull wires attached at the tip just beneath its outer protective sheath, and passing back through the length of the instrument shaft to the two angulation control wheels (for up/down and right/left movement) on the control head (Fig. 2.4). The wheels incorporate a friction braking system, so that the tip can be fixed temporarily in any desired position. The instrument shaft is torque stable, so that rotating movements applied to the head are transmitted to the tip when the shaft is relatively straight.

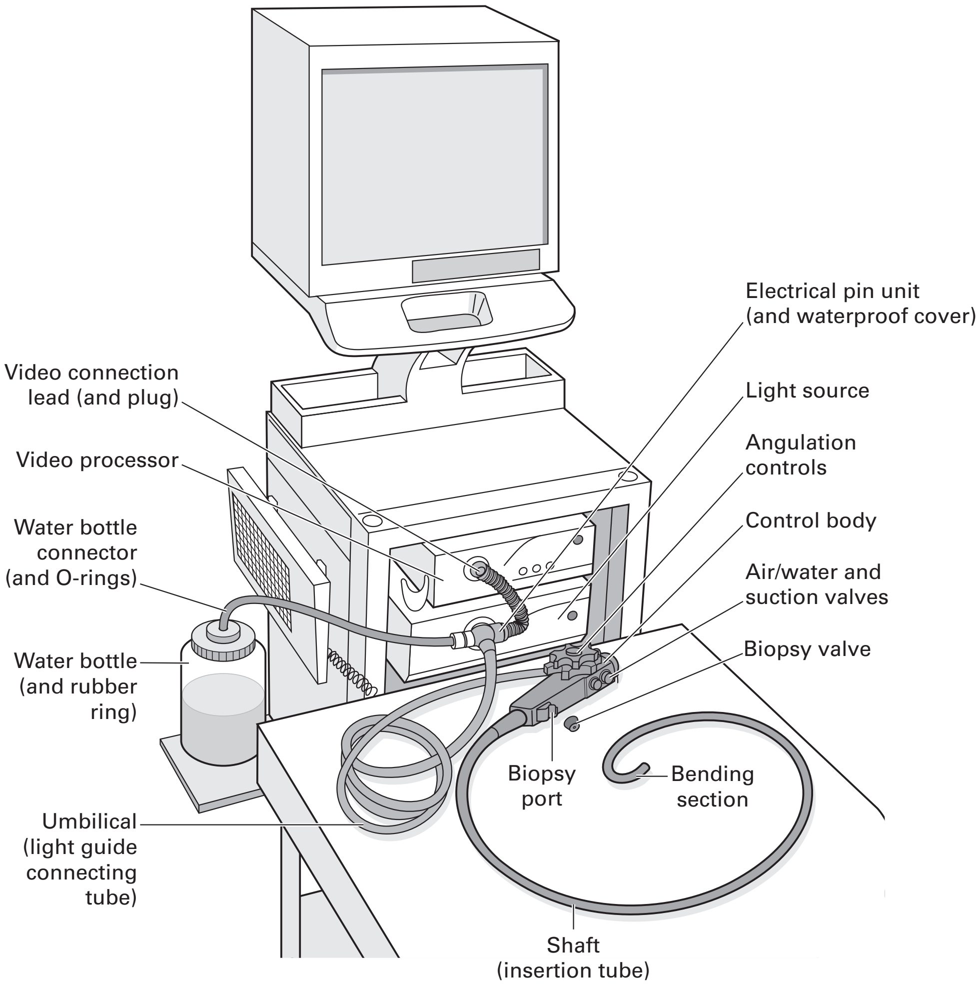

Fig. 2.1 Endoscope system.

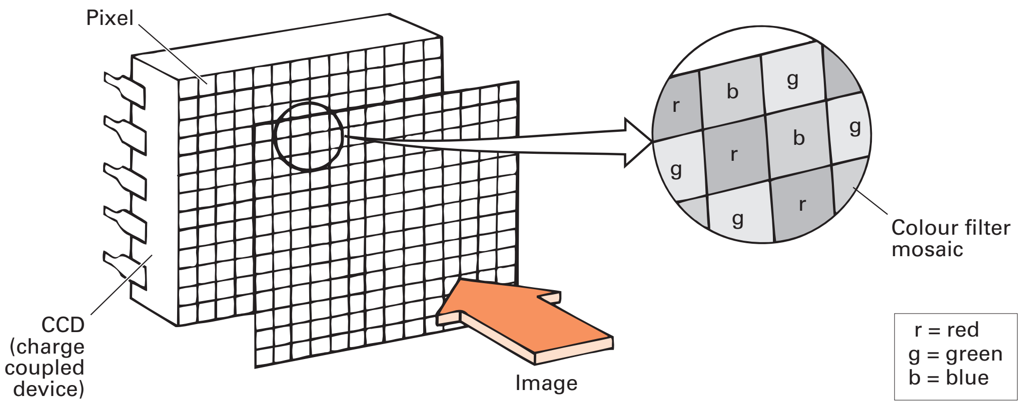

Fig. 2.2 Static red, green and blue filters in the 'color' chip.

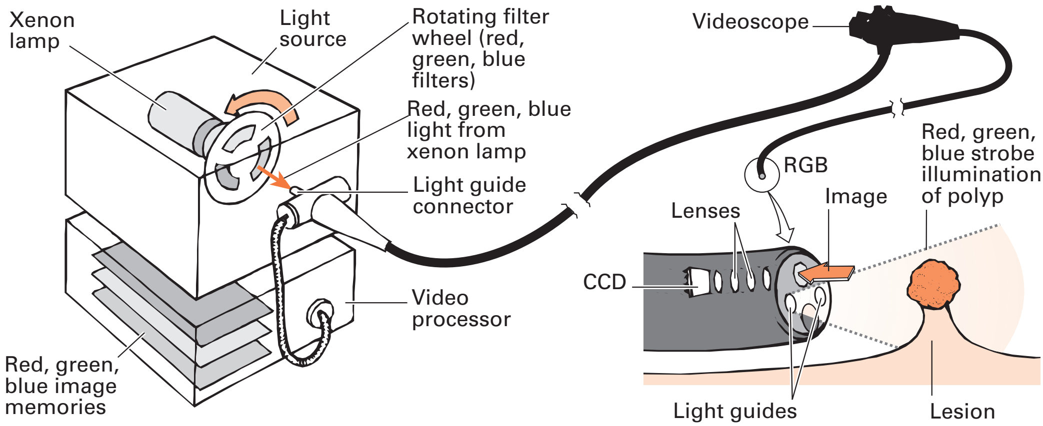

Fig. 2.3 Sequential color illumination.

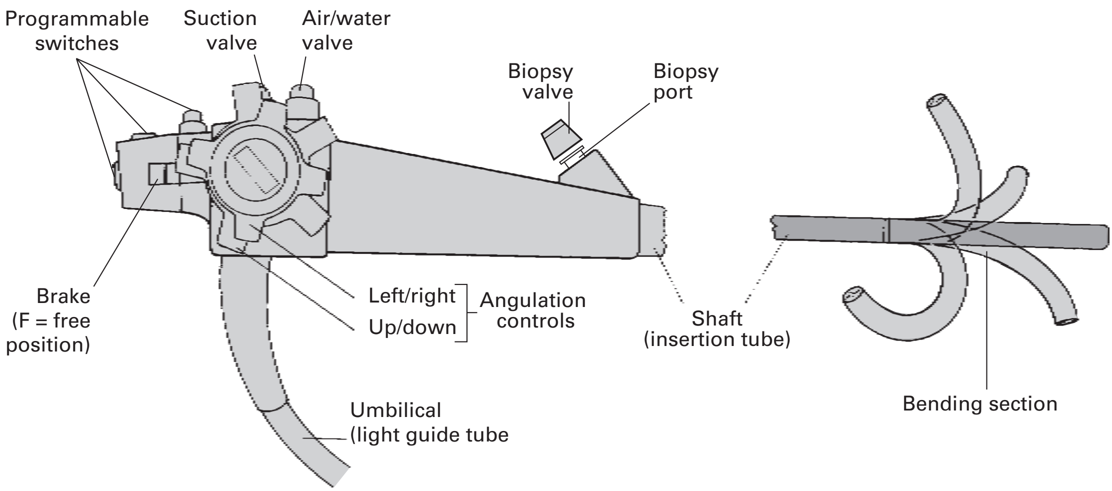

Fig. 2.4 Basic design—control head and bending section.

Instrument channels and valves

The internal anatomy of endoscopes is complex (Fig. 2.5). The shaft incorporates a biopsy/suction channel extending from the entry "biopsy port" to the tip of the instrument. The channel is usually about 3mm in diameter, but varies from 1 to 5mm depending upon the purpose for which the endoscope was designed (from neonatal examinations to major therapeutic procedures). In some instruments, especially those with lateral-viewing optics, the tip of the channel incorporates a deflectable elevator or

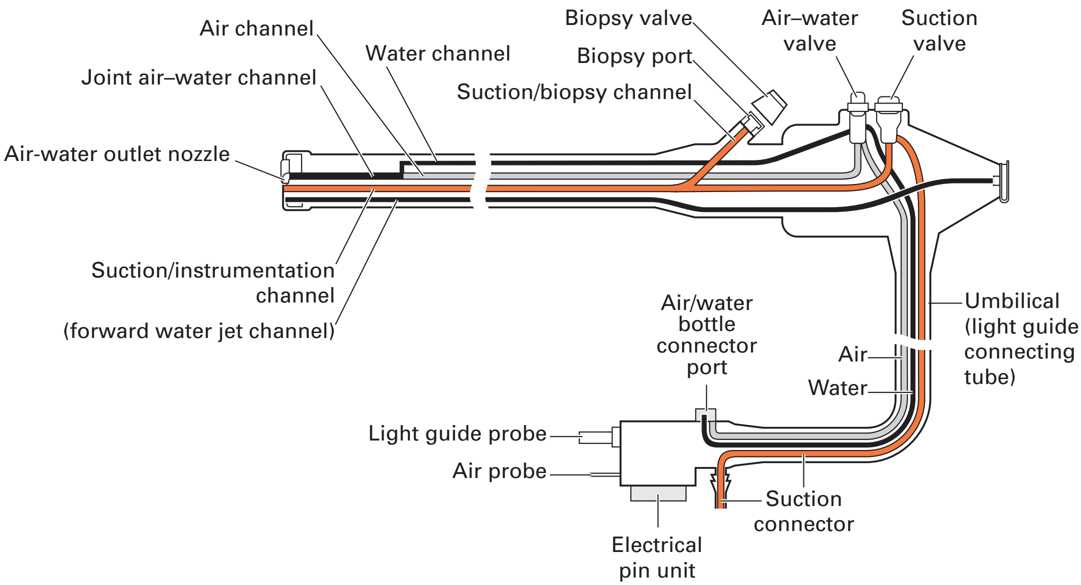

Fig. 2.5 The internal anatomy of a typical endoscope.

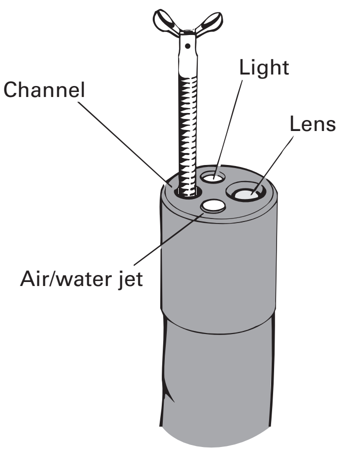

Fig. 2.6 The tip of a forward-viewing endoscope.

bridge (see Fig. 2.7), which permits directional control of forceps and other accessories independent of the instrument tip. This elevator is controlled by a further thumb lever. The biopsy/suction channel is used also for aspirating secretions: an external suction pump is connected to the universal cord near to the light source, and suction is diverted into the instrument channel by pressing the suction valve. Another small channel allows passage of air to distend the organ being examined. The air is supplied from a pump in the light source and is controlled by another valve. For colonoscopy, the air insufflation system can be modified to CO_2 rather than room air. Carbon dioxide has been shown to lessen abdominal distension and pain after colonoscopy. The air system also pressurizes the water bottle, so that a jet of water can be squirted across the distal lens to clean it.

Different instruments

The endoscopy unit must have a selection of endoscopes for specific applications. They may differ in length, size, stiffness, channel size and number, sophistication, and distal lens orientation. Most endoscopies are performed with instruments providing ***direct forward vision***, via a wide-angle lens (up to 130°) (Fig. 2.6). However, there are circumstances in which it is preferable to view ***laterally***, particularly for endoscopic retrograde cholangio-pancreatography (ERCP) (Fig. 2.7).

The overall diameter of an endoscope is a compromise between engineering ideals and patient tolerance. The shaft must contain and protect many bundles, wires, and tubes, all of which are stronger and more efficient when larger (Fig. 2.5). A colonoscope can reasonably approach 15 mm in diameter, but this size is acceptable in the upper gut only for specialized therapeutic instruments.

Routine upper endoscopy is mostly performed with instruments of 8–11 mm diameter. Smaller endoscopes are available; they are better tolerated by all patients and have specific application in children. Some can be passed through the nose rather than the mouth. However, smaller instruments inevitably involve some compromise in durability, image quality, maneuverability, biopsy size, and therapeutic potential.

Several companies now produce a full range of endoscopes at comparable prices. However, light sources and processors produced by different companies are not interchangeable, so that most endoscopy units concentrate for convenience on equipment from a single manufacturer. Endoscopes are delicate, and some breakages are inevitable. Careful maintenance and close communication, repair, and back-up arrangements with an efficient company are necessary to maintain an endoscopy service. The quality of the support is often a crucial factor affecting the choice of manufacturer.

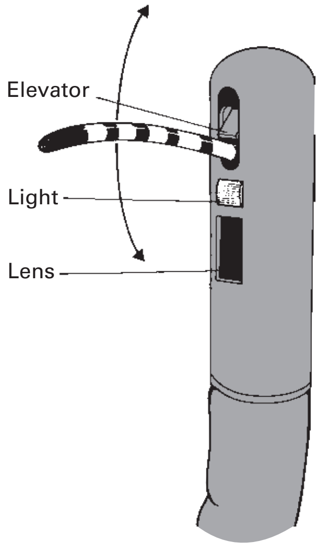

Fig. 2.7 A side-viewer with a deflectable elevator.

Endoscopic accessories

Many devices can be passed through the endoscope biopsy/suction channel for diagnostic and therapeutic purposes.

- ***Biopsy forceps*** consist of a pair of sharpened cups (Fig. 2.8), a spiral metal cable, a pull wire, and a control handle (Fig. 2.9). Their maximum diameter is limited by the size of the channel, and the length of the cups by the radius of curvature through which they must pass in the instrument tip. When taking biopsy specimens from a lesion that can only be approached tangentially (e.g. the wall of the esophagus), forceps with a central spike may be helpful; however, these do present a significant puncture hazard for staff.
- ***Cytology brushes*** have a covering plastic sleeve to protect the specimen during withdrawal (Fig. 2.10).
- ***Injection needles*** are invaluable, and sometimes also used for cell aspiration.
- ***Fluid-flushing devices***. Most instruments have a flushing jet channel to keep the lens clean. Fluids can also be forcibly flushed

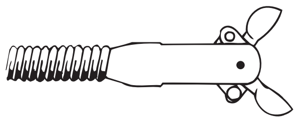

Fig. 2.8 Biopsy cups open.

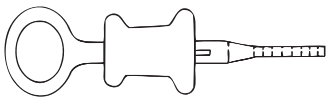

Fig. 2.9 Control handle for forceps.

Fig. 2.10 Cytology brush with outer sleeve.

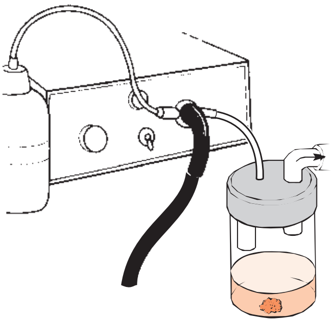

Fig. 2.11 A suction trap to collect fluid specimens.

through the instrumentation channel with a large syringe or a pulsatile electric pump, with a suitable nozzle inserted into the biopsy port. For more precise aiming, a washing catheter can be passed down the channel to clean specific areas of interest, or to highlight mucosal detail by "dye spraying" (using a nozzle-tipped catheter).

Ancillary equipment

- ***Suction traps*** (fitted temporarily into the suction line) can be used to take samples of intestinal secretions and bile for microbiology, chemistry, and cytology (Fig. 2.11, see also Fig. 7.27).
- ***Biteguards*** are used to protect the patient's teeth and the endoscope. Some guards have straps to keep them in place and oxygen ports.
- ***Overtubes*** are flexible plastic sleeves that cover the endoscope shaft and act as a conduit for repeated intubations, or to facilitate therapeutic procedures such as the extraction of a foreign body and hemostasis (Fig. 2.12).
- ***Caps*** of various shapes can be attached to the tip of the endoscope to facilitate various procedures, such as banding and mucosal resection, dissection, etc.
- ***Stretchers/trolleys***. Endoscopy is normally performed on a standard transportation stretcher. This should have side rails, and preferably allow height adjustment. The ability to tilt the stretcher head down may be helpful in emergencies.
- ***Image documentation***. Videoscopes capture images digitally, which can then be enhanced, stored, transmitted, and printed. Video sequences can be recorded on tape or digitally.

Electrosurgical units

Any electrosurgical unit can, if necessary, be used for endoscopic therapy but purpose-built isolated-circuit and "intelligent" units have major advantages in safety and ease of use. Units

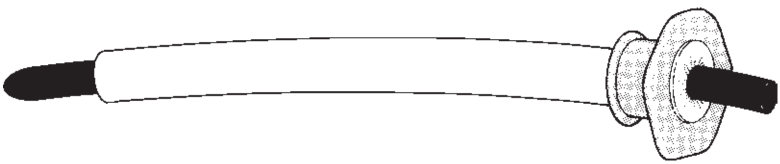

Fig. 2.12 An overtube with biteguard over a rubber lavage tube.

should have test circuitry and an automatic warning system or cut-out in case a connection is faulty or the patient plate is not in contact. Most units have separate "cut" and "coagulate" circuits, which can often be blended to choice. For flexible endoscopy, low-power settings are used (typically 15–50 W). However, an "auto-cut" option is increasingly popular. This uses an apparently higher power setting but gives good control of tissue heating and cutting, because the system automatically adjusts power output according to initial tissue resistance and increasing resistance during coagulation and desiccation.

The type of current is generally less important than the amount of power produced, and other physical factors such as electrode pressure or snare-wire thickness and squeeze are more critical. High settings (high power) of coagulating current provide satisfactory cutting characteristics, whereas units with output not rated directly in watts can be assumed to have "cut" power output much greater than that of "coag" at the same setting. The difference in current type used is therefore often illusory. If in doubt, pure coagulating current alone is considered by most expert endoscopists to be safer and more predictable, giving "slow cook" effect and maximum hemostasis.

Lasers and argon plasma coagulation

Lasers (particularly the neodymium-YAG and argon lasers) were introduced into endoscopy for treatment of bleeding ulcers, and for tumor ablation, because it seemed desirable to use a "no touch" technique. However, it has become clear that the same effects can be achieved with simpler devices, and that pressure (coaptation) may actually help hemostasis.

Argon plasma coagulation (APC) is easier to use and as effective as lasers for most endoscopic purposes. APC electrocoagulates, without tissue contact, by using the electrical conductivity of argon gas—a similar phenomenon to that seen in neon lights. The argon, passed down an electrode catheter (Fig. 2.13a) and energized with an intelligent-circuitry electrosurgical unit and patient plate, ionizes to produce a local plasma arc—like a miniature lightning strike (Fig. 2.13b). The heating effect is inherently superficial (2–3 mm at most, unless current is applied in the same place for many seconds), because tissue coagulation increases resistance and causes the plasma arc to jump elsewhere. However, APC action alone may be too superficial to debulk a larger lesion, requiring preliminary piecemeal snare-loop removal, with APC to electrocoagulate the base.

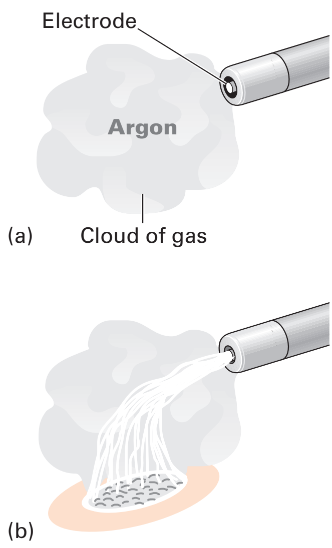

Fig. 2.13 Argon plasma coagulation (APC).

Equipment maintenance

Endoscopes are expensive and complex tools. They should be stored safely, hanging vertically in cupboards through which air can circulate. Care must be taken when carrying instruments, since the optics are easily damaged if left to dangle or knocked against a hard surface. The head, tip, and umbilical cord should all be held (Fig. 2.14).

The life of an endoscope is largely determined by the quality of maintenance. Complex accessories (e.g. electrosurgical equipment) must be checked and kept in safe condition. Close collaboration with hospital bioengineering departments and servicing engineers is essential. Repairs and maintenance must be properly documented.

Channel blockage

Blockage of the air/water (or suction) channel is one of the most common endoscope problems. Special "channel-flushing devic-

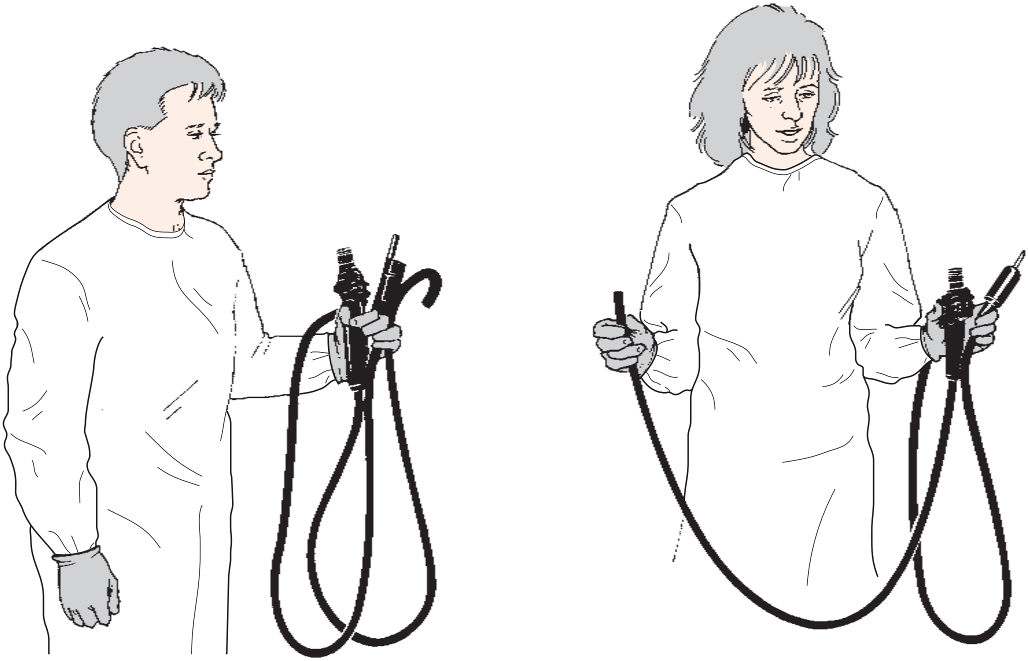

Fig. 2.14 Carry endoscopes carefully to avoid knocks to the optics in the control head and tip.