

Endoscopy

Endoscopy (pronounced /ɛnˈdɒskəpi/) means *looking inside* and typically refers to looking inside the body for medical reasons using an **endoscope** (pronounced /ˈɛndəskoʊp/), an instrument used to examine the interior of a hollow organ or cavity of the body. Unlike most other medical imaging devices, endoscopes are inserted directly into the organ. Endoscopy can also refer to using a borescope in technical situations where direct line-of-sight observation is not feasible.

Components

An endoscope can consist of

- a rigid or flexible tube
- a light delivery system to illuminate the organ or object under inspection. The light source is normally outside the body and the light is typically directed via an optical fiber system
- a lens system transmitting the image to the viewer from the fiberscope
- an additional channel to allow entry of medical instruments or manipulators

Uses

Endoscopy can involve

- The gastrointestinal tract (GI tract):
 - esophagus, stomach and duodenum (esophagogastroduodenoscopy)
 - small intestine (enteroscopy)
 - large intestine\colon (colonoscopy, sigmoidoscopy)
 - Magnification endoscopy
 - bile duct
 - endoscopic retrograde cholangiopancreatography (ERCP), duodenoscope-assisted cholangiopancreatotomy, intraoperative cholangioscopy
 - rectum (rectoscopy) and anus (anoscopy), both also referred to as (proctoscopy)
- The respiratory tract
 - The nose (rhinoscopy)
 - The lower respiratory tract (bronchoscopy)
- The ear (otoscope)
- The urinary tract (cystoscopy)
- The female reproductive system (gynoscopy)
 - The cervix (colposcopy)
 - The uterus (hysteroscopy)
 - The fallopian tubes (falloscopy)
- Normally closed body cavities (through a small incision):



An example of a flexible endoscope



A physician using an endoscope

- The abdominal or pelvic cavity (laparoscopy)
- The interior of a joint (arthroscopy)
- Organs of the chest (thoracoscopy and mediastinoscopy)
- During pregnancy
 - The amnion (amnioscopy)
 - The fetus (fetoscopy)
- Plastic Surgery
- Panendoscopy (or triple endoscopy)
 - Combines laryngoscopy, esophagoscopy, and bronchoscopy
- Orthopedic surgery
 - Hand Surgery, such as endoscopic carpal tunnel release
 - Epidural space (Epiduroscopy)
- Non-medical uses for endoscopy
 - The planning and architectural community have found the endoscope useful for pre-visualization of scale models of proposed buildings and cities (architectural endoscopy)
 - Internal inspection of complex technical systems (borescope)
 - Endoscopes are also a tool helpful in the examination of improvised explosive devices by bomb disposal personnel.
 - The FBI uses endoscopes for conducting surveillance via tight spaces.

History

Early

The first endoscope, of a kind, was developed in 1806 by Philip Bozzini with his introduction of a "Lichtleiter" (light conductor) "for the examinations of the canals and cavities of the human body". However, the Vienna Medical Society disapproved of such curiosity. An endoscope was first introduced into a human in 1822 by William Beaumont, an army surgeon at Mackinac Island, Michigan. The use of electric light was a major step in the improvement of endoscopy. The first such lights were external. Later, smaller bulbs became available making internal light possible, for instance in a hysteroscope by Charles David in 1908. Hans Christian Jacobaeus has been given credit for early endoscopic explorations of the abdomen and the thorax with laparoscopy (1912) and thoracoscopy (1910). Laparoscopy was used in the diagnosis of liver and gallbladder disease by Heinz Kalk in the 1930s. Hope reported in 1937 on the use of laparoscopy to diagnose ectopic pregnancy. In 1944, Raoul Palmer placed his patients in the Trendelenburg position after gaseous distention of the abdomen and thus was able to reliably perform gynecologic laparoscopy.

Storz

Karl Storz began producing instruments for ENT specialists in 1945. His intention was to develop instruments which would enable the practitioner to look inside the human body. The technology available at the end of the Second World War was still very modest: The area under examination in the interior of the human body was illuminated with miniature electric lamps; alternatively, attempts were made to reflect light from an external source into the body through the endoscopic tube. Karl Storz pursued a plan: He set out to introduce very bright, but cold light into the body cavities through the instrument, thus providing excellent visibility while at the same time allowing objective documentation by means of image transmission. With more than 400 patents and operative samples to his name, which were to play a major role in showing the way ahead, Karl Storz played a crucial role in the development of endoscopy. It was however, the combination of his engineering skills and vision, coupled with the work of optical designer Harold Hopkins that ultimately would revolutionize the field of medical optics.

Development of the Gastroscope

The gastroscope was first developed in 1952 by a Japanese team of a doctor and optical engineers. Mutsuo Sugiura, in association with Olympus Corporation, worked with Dr. Tatsuro Uji and his subordinate, Shoji Fukami, to develop what he first called a "gastro camera". It consisted of a tiny camera attached to a flexible tip with a light bulb. With it, they were able to photograph stomach ulcers that were undetectable by X-ray and find stomach cancers in early stage.

Fiber Optics

In the early 1950s Harold Hopkins designed a "fibroscope" (a coherent bundle of flexible glass fibres able to transmit an image), which proved useful both medically and industrially. The subsequent research and development of these fibres, led to further improvements in image quality. Further innovations included using additional fibres to channel light to the objective end from a powerful external source - thereby achieving the high level of full spectrum illumination that was needed for detailed viewing and colour photography. (The previous practice of a small filament lamp on the tip of the endoscope had left the choice of either viewing in a dim red light or increasing the light output at the risk of burning the inside of the patient.) Alongside the advances to the optical side, came the ability to 'steer' the tip via controls in the endoscopists hands and innovations in remotely operated surgical instruments contained within the body of the endoscope itself. It was the beginning of key-hole surgery as we know it today. Fernando Alves Martins, from Portugal, invents the first fibre optics endoscope (1963/64)

Rod-lens Endoscopes

However, there were physical limits to the image quality of a fibroscope. In modern terminology, a bundle of say 50,000 fibers gives effectively only a 50,000 pixel image - in addition to which, the continued flexing in use, breaks fibers and so progressively loses pixels. Eventually so many are lost that the whole bundle must be replaced (at considerable expense). Hopkins realised that any further optical improvement would require a different approach. Previous rigid endoscopes suffered from very low light transmittance and extremely poor image quality. The surgical requirement of passing surgical tools as well as the illumination system actually within the endoscope's tube - which itself is limited in dimensions by the human body - left very little room for the imaging optics. The tiny lenses of a conventional system required supporting rings that would obscure the bulk of the lens' area; they were incredibly hard to manufacture and assemble and optically nearly useless. The elegant solution that Hopkins produced (in the late 1960s) was to fill the air-spaces between the 'little lenses' with rods of glass. These fitted exactly the endoscope's tube - making them self-aligning and requiring of no other support and allowed the little lenses to be dispensed with altogether. The rod-lenses were much easier to handle and utilized the maximum possible diameter available. With the appropriate curvature and coatings to the rod ends and optimal choices of glass-types, all calculated and specified by Hopkins, the image quality was transformed - even with tubes of only 1mm. in diameter. With a high quality 'telescope' of such small diameter, the tools and illumination system could be comfortably housed within an outer tube. Once again, it was Karl Storz who produced the first of these new endoscopes as part of a long and productive partnership between the two men. Whilst there are regions of the body that will forever require flexible endoscopes (principally the gastrointestinal tract), the rigid rod-lens endoscopes have such exceptional performance that they are to this day the instrument of choice and in reality have been the enabling factor in modern key-hole surgery. (Harold Hopkins was recognized and honoured for his advancement of medical-optic by the medical community worldwide. It formed a major part of the citation when he was awarded the Rumford Medal by the Royal Society in 1984.)

Disinfection: Of essential importance is the disinfection of the fibre endoscopes within a suitable time. The first disinfection device was constructed by S.E.Miederer 1976 at the University of Bonn/Germany.

Risks

- Infection
- Punctured organs
- Over-sedation

After the endoscopy

After the procedure the patient will be observed and monitored by a qualified individual in the endoscopy or a recovery area until a significant portion of the medication has worn off. Occasionally a patient is left with a mild sore throat, which promptly responds to saline gargles, or a feeling of distention from the insufflated air that was used during the procedure. Both problems are mild and fleeting. When fully recovered, the patient will be instructed when to resume their usual diet (probably within a few hours) and will be allowed to be taken home. Because of the use of sedation, most facilities mandate that the patient is taken home by another person and not to drive on their own or handle machinery for the remainder of the day.

Recent developments

Capsule Endoscopy.

With the application of robotic systems, telesurgery was introduced as the surgeon could operate from a site physically removed from the patient. The first transatlantic surgery has been called the (Lindbergh Operation)

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