OLYMPUS

Your Vision, Our Future

The Olympus Medical Business:

Profile and Perspectives, 1950-Present

Olympus Group Corporate Philosophy

Social IN

INtegrity	INnovation	INvolvement
Integrity in Society	Creating Innovative Value	Social Involvement

The Olympus Group strives to realize better health and happiness for people by being integral members of society, sharing common values, and proposing new values through its business activities.

Introduction

Olympus developed the world's first practical gastrocamera in 1950. This innovative device contributed greatly in establishing methods for the early diagnosis of stomach cancer, a kind of cancer that had previously been a leading cause of death in Japan. Since then, Olympus has strived to make further developments with the use of endoscopes for various forms of examination and treatment. Advancements in "minimally invasive therapy" are continuously being made within the field of medicine. Surgeries that in the past were operated by opening the abdomen can now be performed using an endoscope inserted through a small incision, in most cases leaving minimal scarring only. As a result, the patient's pain and suffering is reduced and quality of life (QOL) is significantly improved.

By publishing "The Olympus Medical Business" we hope to provide our investors, shareholders and the public with a general understanding of the medical business of Olympus. We will also introduce recent trends in endoscopic diagnosis and treatment.

Olympus PR/IR Department

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Medical Business of Olympus

Olympus Largest Business Domain: from Earl

Early Diagnosis

Detection	Diagnosis	Biopsy/Collection

Video endoscopy systems

Magnifying endoscopes
Ultrasound endoscopes

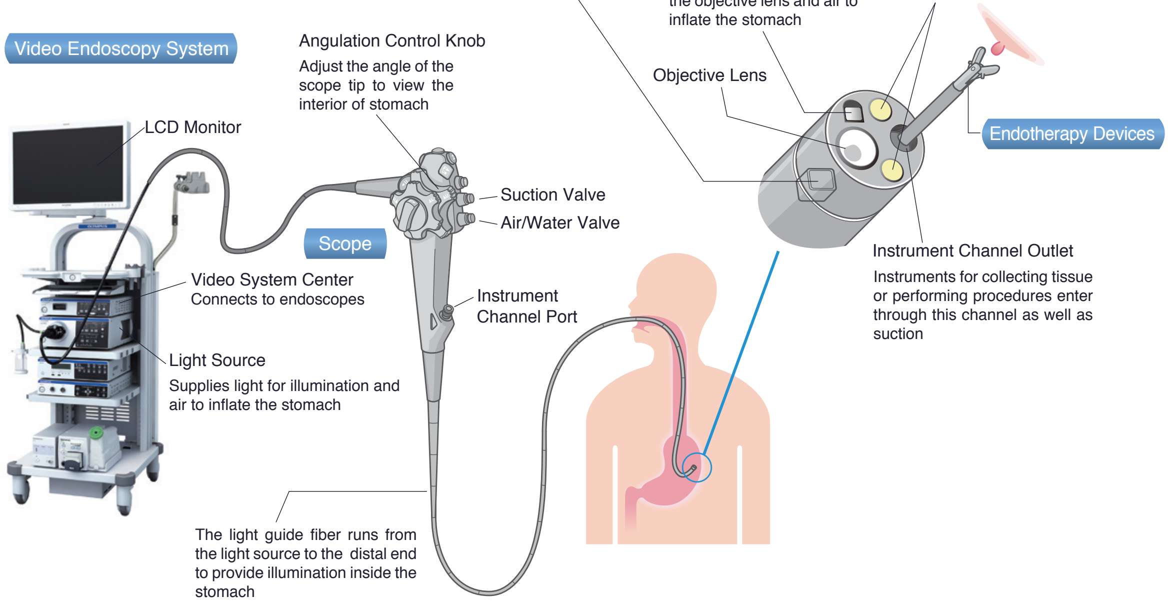
Biopsy forceps
Cytology brushes

Gastrointestinal Endoscopes / Endotherapy Devices

- Olympus gastrointestinal endoscopes with 70% global market share can be used for both diagnosis and treatment.
- Olympus strengths lie in its leading-edge technologies and an ability to develop products that meet doctors' needs, such as Narrow Band Imaging (NBI).

Early Diagnosis

Examples of Endoscopic Examination



Scope types

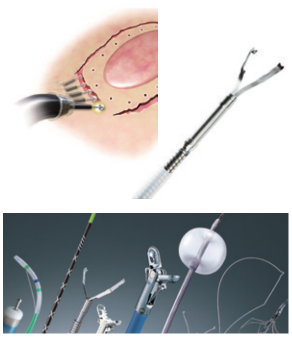
Flexible Endoscopes

Suitable for examination and treatment of internal organs by utilizing the flexibility of the insertion tube and distal end to insert the scope through the mouth or nose, for example.

y Diagnosis to Minimally Invasive Therapy

Minimally Invasive Therapy

Endoscopic therapy | Endoscopic surgery | General surgery



Endotherapy devices

Surgical endoscopy systems

Therapeutic energy devices

Surgical devices

• A comprehensive range of surgical products that extend from diagnosis to therapy based upon the technology for the development of Gastrointestinal Endoscopes.

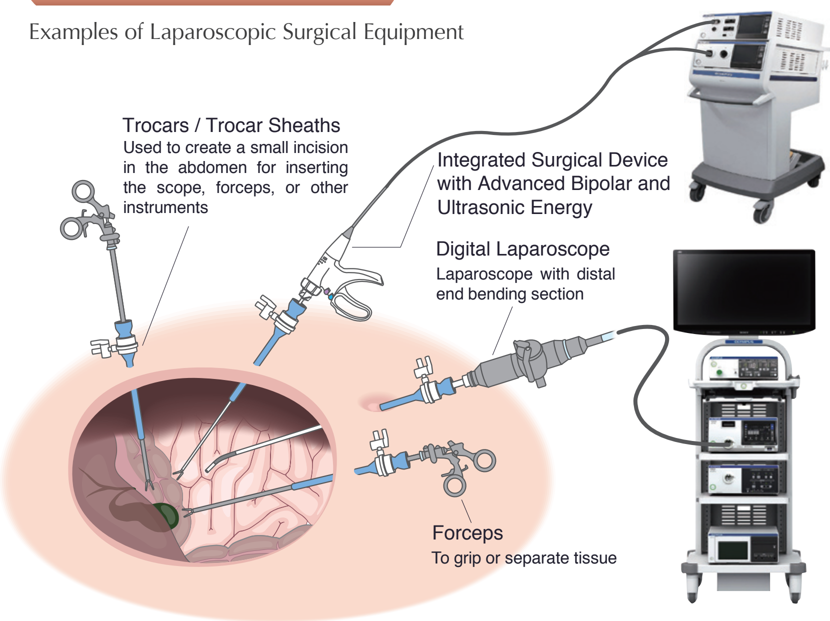
• Creating a new market for minimally invasive surgery using our new generation of THUNDERBEAT electrosurgical devices.

Rigid Endoscopes

Suitable for laparoscopic surgical procedures such as laparoscopy and cystoscopy using a rigid endoscope made from a lens contained in a metal tube.

Minimally Invasive Therapy

Examples of Laparoscopic Surgical Equipment



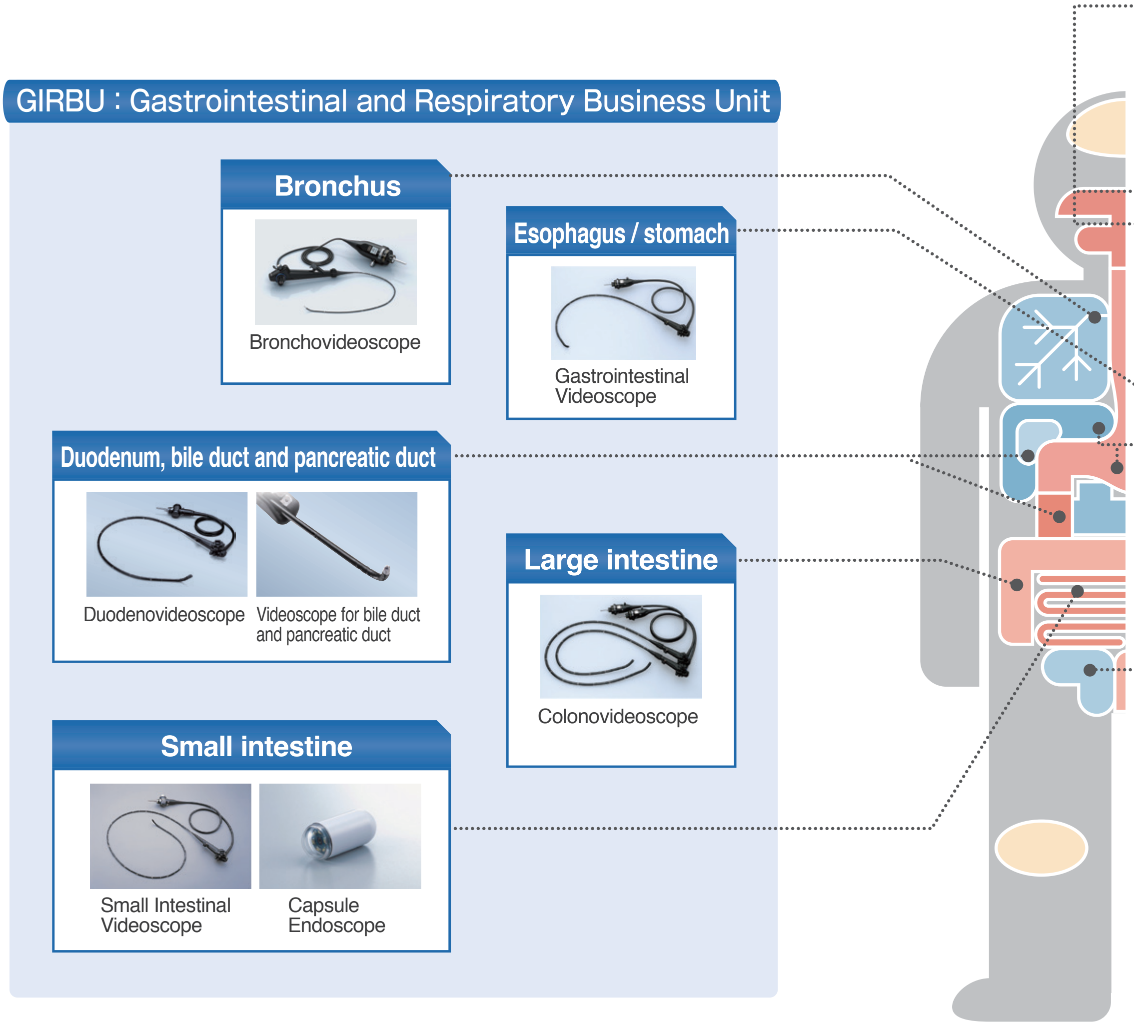
Electrosurgical Devices

Converts electrical energy into ultrasonic vibration, high-frequency current to cut tissue or stop bleeding (coagulation).

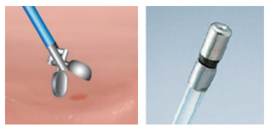
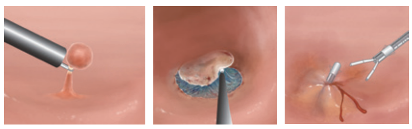
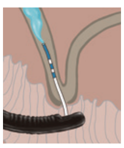
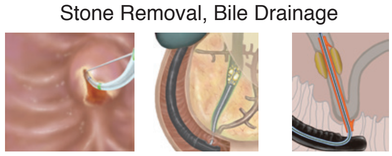
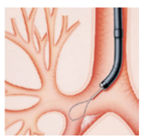
Surgical Endoscopes and Scopes

Connecting a scope to a surgical endoscopy system.

A range of endoscopes to suit different purpo

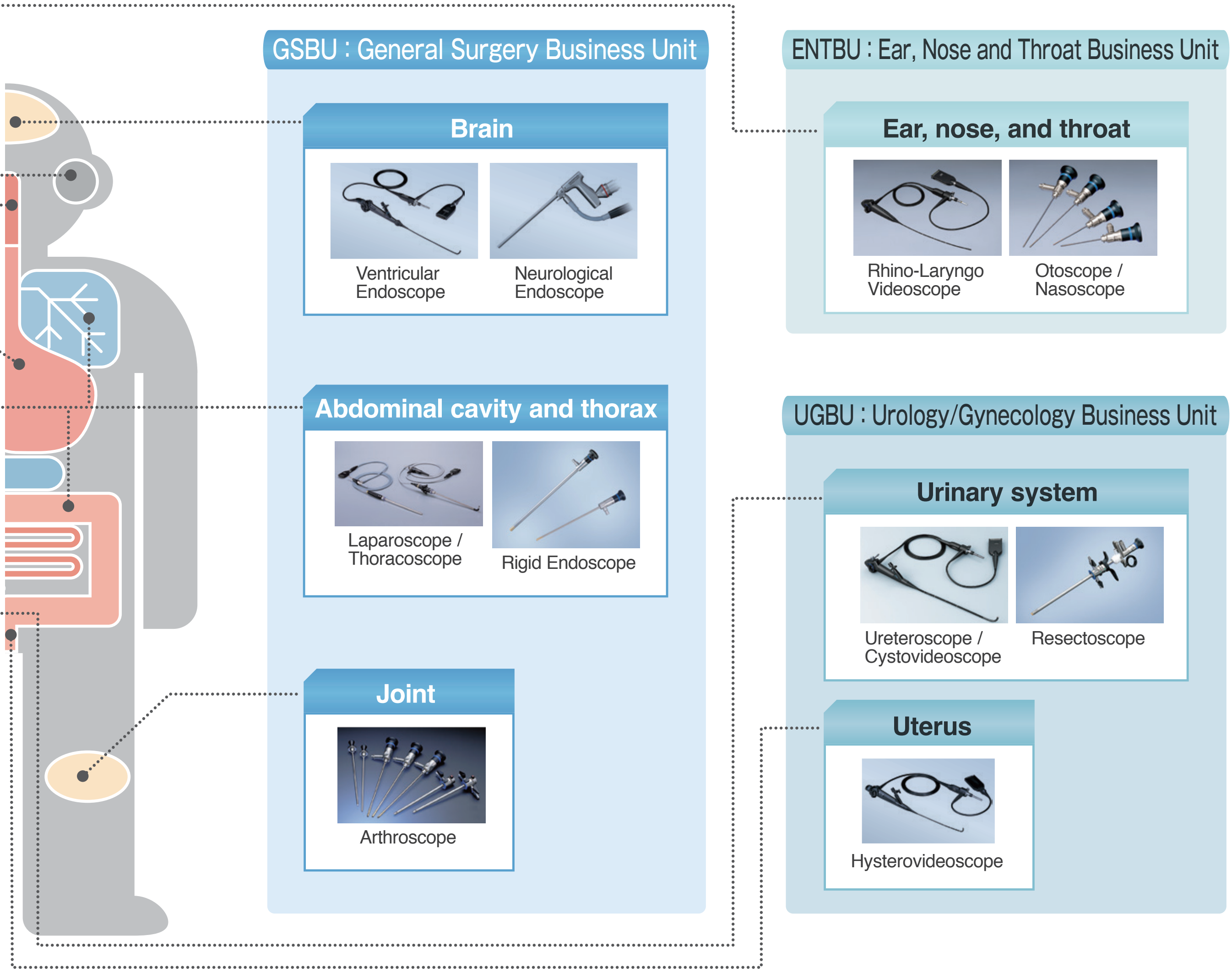


Main scopes, surgical and endotherapy device ranges for each BU

BU	Scopes	Diagnostic Instruments	Clinical Instruments
GIRBU	Gastrointestinal Videoscope, Colonovideoscope 	Tissue Sampling and Spraying of Diagnostic Agents  Biopsy Forceps, Spraying tube	Lesion Resection, Hemostasis  Electrosurgical Snare, Electrosurgical Knife, Hemostasis Clip Fixing Device
	Duodenovideoscope 	Bile duct and Pancreatic duct Imaging  Cannula	Stone Removal, Bile Drainage  Papillotome, Mechanical Lithotriptor, Biliary Stent
	Bronchovideoscope 	Cell and Tissue Sampling  Cytology Brush	Lesion Resection  Electrosurgical Snare

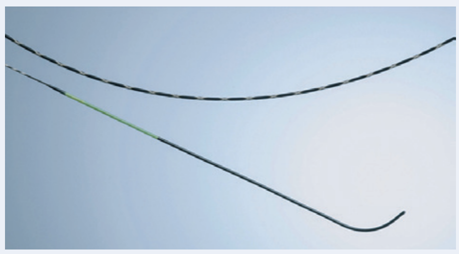
*BU: Business Unit

ses and parts of the body

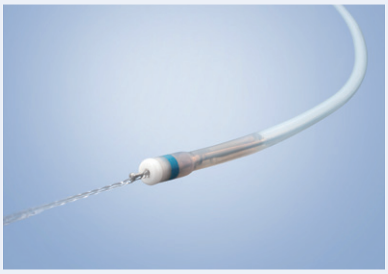
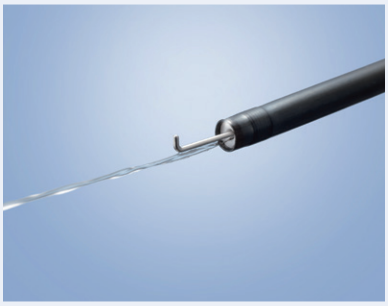


BU	Description	Scopes	Surgical Devices
GSBU	Open a small incision in chest or abdomen to remove lesions	Video Laparoscope 	 Ultrasonic Coagulation and Cutting Devices;  Electrosurgical Knives
UGBU	Diagnosis of urinary system lesions	Cystovideoscope 	
	Treatment of prostate, bladder, or kidneys through the urethra	Resectoscope  Ureteroscope 	Electrosurgical Unit 
	Diagnosis of lesions in uterus	Hysterovideoscope 	
ENTBU	Diagnosis of lesions in ear or nose	Rhino-Laryngo Videoscope 	
	Removal of diseased mucosa of paranasal sinuses, resection / suction / cutting of tissue	Camera head  Telescope 	Handpiece and blades 

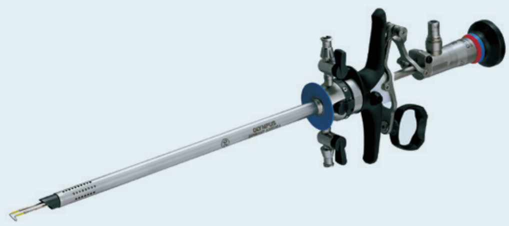
Latest Medical Devices

BU	Model		Main diagnosis and treatment department	Photograph
GIRBU	Video Endoscopy System	EVIS EXERA III (Mainly for Europe and America) EVIS LUCERA ELITE (Mainly for Japan)	Gastroenterology	
		EU-ME2		Endoscopic Ultrasound Center 
	Endoscope Reprocessor	OER-3 (For Japan) OER-Pro (For America) OER-AW (For Asia/Oceania)		
	Single-Use Guidewire	VisiGlide 2™		
	Single-Use Repositionable Clip	QuickClip Pro™		

Availability	Features	Competitors
- Japan: From November 2012 - America: From April 2012 - Europe: From April 2012 - Other markets: Upon regulatory approval (China: From September 2014)	- Visualizes organ tissue with bright NBI images for detailed observation. - Dual Focus function supports more reliable diagnosis by allowing instant magnification of suspect sites while still providing a wide-angle view. - Improved performance of insertion section and passive bending section makes colonoscopy insertion process easier for both doctor and patient. - Fully waterproof single-action design simplifies examination preparation and cleaning / disinfection process. Reduces workload for doctors and co-medicals. < Differences between EXERAIII & LUCERA > Different sales region due to different image system LUCERA ⇒ Mainly sold in Japan (designed for still images) EXERA ⇒ Mainly sold in Europe and America (designed for video images)	- FUJIFILM Medical Co., Ltd. - HOYA CORPORATION
- Japan: From September. 2013 - America: From May. 2014 - Europe: From September. 2013 - Other markets: Upon regulatory approval	- Fine tunes the ultrasound transmission / reception process, thereby realizing higher resolution images than conventional products. - Supports better detection and characterization of lesions such as tumor and blood flow, contributing to determination of treatment policy. - Various functions such as tissue harmonic echo (noise reduction) and elastography are available.	
- Japan: From December. 2006 - America: From March. 2008 - Europe: Different type of washing and disinfecting machine released - Other markets: From December. 2007 (released in some markets)	- Able to simultaneously disinfect two scopes. - Washing history function to support medical risk management. - Capable of either using a ready-to-use disinfectant or a concentrated disinfectant sealed in dedicated cassette bottles. - Washing and disinfecting functions take account of endoscope structure.	· ASP, Johnson & Johnson (USA) · STERIS (USA) · Medivators (USA) · Wassenburg & CO BV (Germany)
- Japan: From June 2014 - America: From October. 2014 - Europe: From October. 2014 - Other markets: Upon regulatory approval	- Instrument for gaining entry into the pancreatic or bile duct from duodenal papilla. Because the pancreatic duct and bile duct are among the most difficult organs in the digestive tract to access, a separate pancreatic and bile duct instrument are used after first inserting this guide wire to determine the route. - Wire tips that are both flexible and firm provide smooth access to the pancreatic or bile duct.	- Boston Scientific (USA) - Cook Medical (USA)
- Japan: From November. 2014 - America: From August. 2014 - Europe: From September. 2014 - Other markets: Upon regulatory approval	- The clips can be repositioned being rotatable and having a reliable opening width. - Well-regarded ability to rotate 360 degrees facilitates clipping at appropriate point for halting bleeding.	

BU	Model		Main diagnosis and treatment department	Photograph
GIRBU	Single-Use Electrosurgical Knife	ITKnife2™	Gastroenterology	
		DualKnifeJ™		
		HookKnifeJ™		
GSBU	4K Surgical Endoscopy System	VISERA 4K UHD	General Surgery Digestive Surgery Respiratory Surgery Urologic Surgery Gynecologic Surgery Otorhinology	

Availability	Features	Competitors
- Japan: From January. 2007 - America: From August. 2011 - Europe: From February. 2007 - Other markets: Upon regulatory approval	- Electrodes radiate in three directions from knife tip. - Dramatic improvement in ease of lateral cutting. Helps achieve efficient ESD thanks to improvement in ease of cutting from vertical direction. * ESD: Endoscopic Submucosal Dissection	· Boston Scientific (USA) · Cook Medical (USA)
- Japan: From October. 2015 - America: To be determined - Europe: From October. 2015 - Other markets: Upon regulatory approval	- Two different models of knife are available with different cutting lengths and effective sheath lengths to enable combined use for upper intestinal tract and bowel respectively. - New fluid delivery function enables injections to be performed without needing to swap the device for a syringe. Helps achieve more accurate ESD and shorter procedure times. * ESD: Endoscopic Submucosal Dissection	
- Japan: From October. 2015 - America: To be determined - Europe: From October. 2015 - Other markets: Upon regulatory approval	- Use of tip hook to pull up the mucosa for cutting means cutting and peeling can be performed from both lateral and vertical directions. - Ability to rotate enables cutting and peeling to be supported correctly in the desired direction, helping achieve more accurate ESD and shorter procedure times. * ESD: Endoscopic Submucosal Dissection	
- Japan: From October. 2015 - America: From March. 2016 - Europe: From October. 2015 - Other markets: Upon regulatory approval	- Entire imaging chain is optimized for 4K, producing enhanced visibility with an extremely bright image. - Utilizing an expanded color space, this system can display over 1 billion colors compared to conventions imaging systems that produce roughly 16 million colors. - 4K enables the use of a large primary operative display enlarging ultra-high definition images for greater clarity and therefore accuracy.	· Karl Storz (Germany) · Stryker (USA) · Richard Wolf (Germany) · Arthrex (USA)

BU	Model		Main diagnosis and treatment department	Photograph
GSBU	Surgical Endoscope System	VISERA ELITE Ⅱ	General Surgery Digestive Surgery Respiratory Surgery Urologic Surgery Gynecologic Surgery Otorhinology	
	Integrated Surgical Device with Advanced Bipolar and Ultrasonic Energy	THUNDERBEAT	General Surgery Digestive Surgery Respiratory Surgery Urologic Surgery Gynecologic Surgery	
UGBU	Cysto-Nephro Videoscope	CYF-VHA	Urology	
	Resectoscope System	OES ELITE	Urology Gynecology	
ENTBU	Multidebrider	DIEGO ELITE	Rhinology	

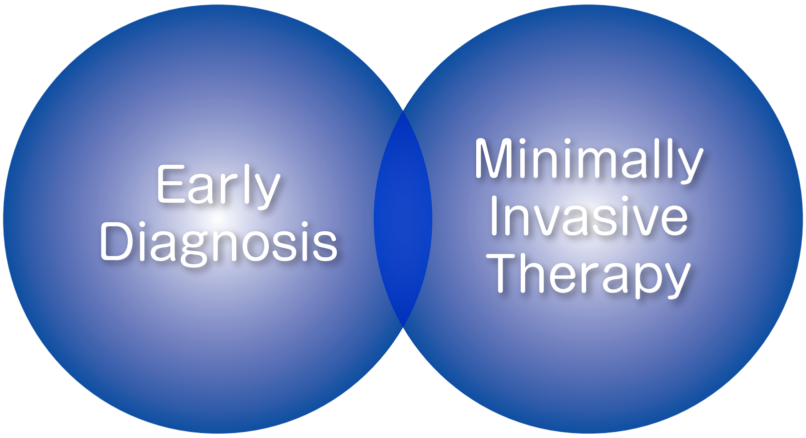
Availability	Features	Competitors
- Japan: From March. 2017 - America: To be determined - Europe: From March. 2017 - Other markets: Upon regulatory approval	- The system supports a variety of different imaging modes, including IR*, NBI, 3D, and 2D as well as white light imaging, helping reduce the risk of complications and shorten surgery times. - The new model has a much more compact design than its conventional products by combining the processor, light source, and 3D image processing unit into one box (both size and weight reduced by about 30%). - Features that facilitate theater operation include adopting a touch panel and LED light source, making the camera head and scope easier to use, and simplifying maintenance. By helping make workflows more efficient, these maximize the quality of treatment by providing an environment in which medical and other staff can focus on the surgery. * IR imaging Because it can provide a real time indication of things that are difficult to view under white light, such as identifying lymph and bile ducts or judging blood flow in blood vessels, the efficacy of IR imaging is currently a subject of study in the medical field.	· Karl Storz (Germany) · Stryker (USA) · Richard Wolf (Germany) · Arthrex (USA)
- Japan: From October 2013 - America: From May 2012 - Europe: From March 2012 - Other markets: Upon regulatory approval (China: From September 2015)	- Combines excellent hemostatic capabilities (controlling bleeding) of bipolar high-frequency energy with precise dissection of ultrasonic energy. - A single device capable of multiple tasks, vessel sealing, hemostasis, coagulation, incision speed and dissection meet surgeon's demands for superior medical effectiveness.	· Ethicon Endo-Surgery.Inc (USA) · Medtronic (USA) · Applied Medical (USA)
- Japan: From October. 2011 - America: From October. 2011 - Europe: From February. 2012 - Other markets: Upon regulatory approval	- Built-in CCD compatible with High-Definition (HDTV). Contributing to improvement of diagnostic accuracy of cystoscopy by white light, NBI by high-definition image. - Supports minimized patient discomfort when inserting the endoscope by making the distal end (evolutiontip) of the scope thinner and smoother.	· Karl Storz (Germany) · Richard Wolf (Germany) · Boston Scientific (USA) · Cook Medical (USA) · CR. Bard (USA)
- Japan: From September. 2015 - America: From April. 2016 - Europe: From January. 2015 - Other markets: Upon regulatory approval	- Lightest resectoscope on the market (at this time) achieved through choice of materials and manufacturing techniques. - New design provides dramatically improved balance. This supports reduced fatigue and makes the resectoscope even easier to use during surgery. - Use of an elliptical outer sheath supports minimized patient discomfort. - Chromatic aberration reduced by use of extra-low dispersion (ED) lens. Higher contrast and less color bleeding than the conventional products.	
- Japan: From July. 2015 - America: From September. 2013 - Europe: From September. 2013 - Other markets: Upon regulatory approval	- In endoscopic sinus surgery, resection, suction and cutting of tissue such as sinus mucosa and nasal bone are performed, and opens the natural orifice of each paranasal sinus. - Contributes to prompt hemostasis operation by blades equipped with Bi-polar and Mono-polar energy. - "Declog System" to quickly eliminate tissue clogging inside the blade contributes to shortening of operation time.	· Medtronic (USA)

Strengths of Olympus Medical Business

Focus on Early Diagnosis and Minimally Invasive Therapy

Olympus is pursuing technological advances in the fields of early diagnosis, particularly in terms of gastrointestinal endoscopes, and minimally invasive therapy with emphasis placed on surgical devices. Through these efforts, we hope to contribute to improvements in the quality of life of patients while also helping to address the worldwide trend of rising healthcare costs.

Value to Be Provided by Medical Business



Product Development Based upon Trustworthy Relationships Established with Physicians over Many Years

From the time when Olympus developed the world's first practical gastrocamera in 1950 to today, the Company has continued to refine its endoscope technologies in close collaboration with physicians. Endoscopes require precise design and functionality, and we have worked with physicians over the course of many years to enhance and improve the specifications of our products to achieve this important threshold of operability. This committed effort is one reason Olympus is the world's leader in endoscopes.

Solid Operations

Aiming to provide the leading technologies, products, services and solutions all over the world, Olympus is developing networks in the Medical Business that reach across the globe.

I Training & Education Center — Support for Nurturing Endoscopists

II Repair Service — Global Network Across 6 Continents

III Manufacturing Technology — Craftsmanship for Meeting Physician Needs

Training & Education Center Support for Nurturing Endoscopists

Demand for early diagnosis and minimally invasive therapy is expanding along with the rapid economic growth in emerging markets, particularly China. As in Japan, the U.S., and Europe, Olympus actively supports the nurturing of doctors by providing training opportunities on the safe and effective use of Olympus products, which allows doctors to be familiar with new equipment and procedures in emerging countries.

Efforts in China

In addition to the progress which the Chinese government is making in reforming medical care, China's population is also rapidly aging in a manner similar to U.S. and European countries. In medical facilities, therefore, the number of endoscopists are unable to keep up with the growing number of patients, making the development of new endoscopists an urgent matter. Olympus built the Shanghai Medical Training & Education Center in 2008 in the research and industry development district outside of Shanghai in China. This site is conveniently located near Shanghai Airport, making it easy for doctors to visit from all over China. Behind the futuristic exterior of the building are located both a training center and a call center. The training center is set up to allow for the performance of gastrointestinal endoscopic examinations, as well as training on the operation of endotherapy devices and surgical equipment. A lecture hall capable of seating close to 100 people is located on the uppermost floor and is wired for high-capacity broadband communications, making academic exchange possible for doctors both inside and outside China. Training of sales representatives and repair and service technicians is also performed at Shanghai Medical Training & Education Center, which contributes to improve the quality of Olympus' marketing services. The call center handles communications with medical facilities, sales representatives repair technicians and dealers throughout the country, with an equivalent level to that of U.S. and Europe. Olympus opened similar training centers in Beijing in 2010 and in Guangzhou in 2013, further accelerating support for nurturing new Chinese endoscopists.

Panorama of Olympus (China) Medical Training & Education Center in Shanghai

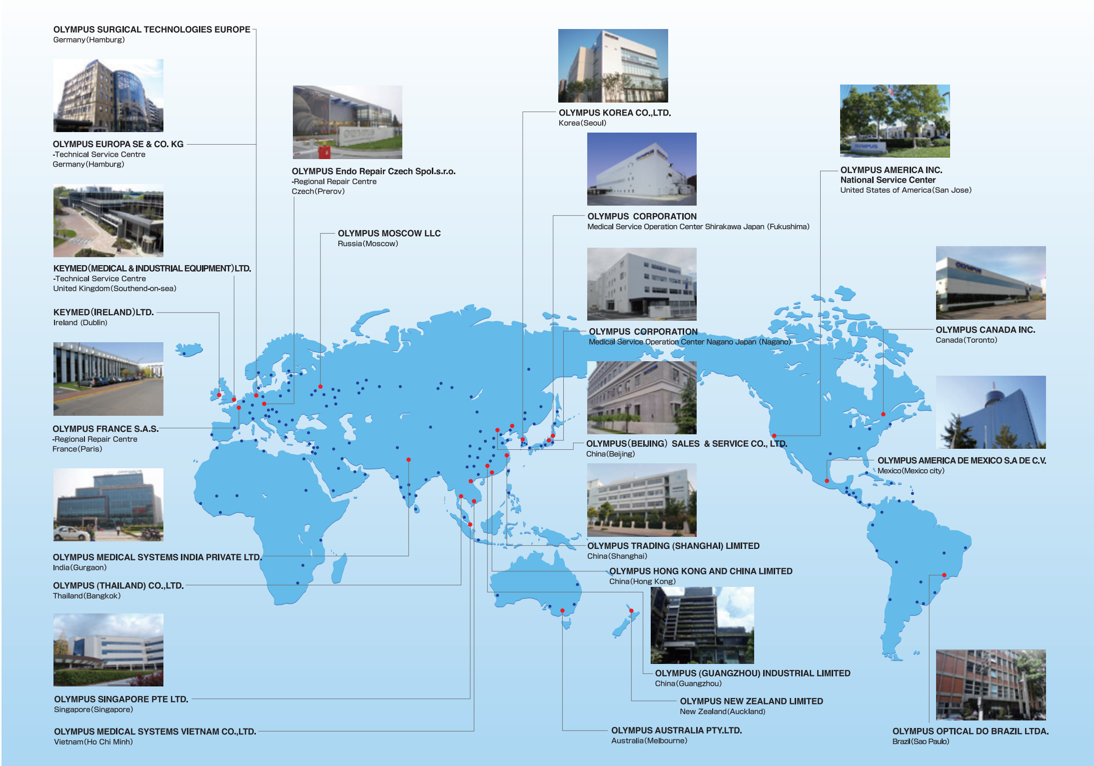

Various forms of training can be given within the facility

Efforts in Asian countries

With a total population of over 1.2 billion people, India is the most promising new market second to China. It is here that Olympus is steadily executing its business strategies. From the size of its population and the speed of its economic growth, it is believed that the availability and use of medical equipment in India will advance rapidly in the future. As with Japan and China, there are a number of gastrointestinal diseases in India amenable to endoscopic treatment, and endoscopic procedures for biliary and pancreatic diseases are very common. Olympus works with Indian academic societies and supports over 150 endoscopic training sessions annually. Having established a training center in Thailand in 2016 to serve medical personnel from Southeast Asia, Olympus is also striving to develop the medical technology infrastructure in the nations of the region and expand their use of endoscopy. In the future, Olympus intends to continue contributing to improvements in patient quality of life (QOL) by working to help with endoscopy skill development and on the wider use of endoscopes for early diagnosis, minimally invasive therapy and surgery. These plans include the establishment of further training centers in other parts of Asia.


T-TEC (Thai-Training and Education Center)

Global Network Across 6 Continents



Map of Olympus' repair locations around the world (● shows locations capable of major repairs*)

Endoscopes are precision instruments used within the human body. High quality after-sales service is necessary to maintain safety and provide maximum functionality. In order for patients around the world to receive safe endoscopic examination and treatment, Olympus has established the industry's leading global repair & services system.

The World's Largest Endoscope Repair Center

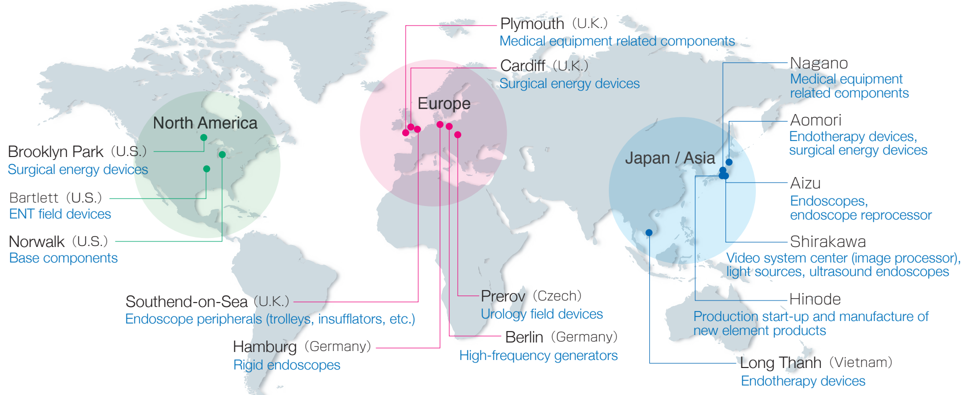
World's largest endoscope repair center
(San Jose, California)

San Jose, California, U.S. Olympus is proud of the "San Jose National Repair Service Center," the world's largest endoscope repair center. Within the walls of the 80,000 square-meter building accented in blue, Olympus' corporate color, 250 service staff members dressed in white lab coats meticulously carry out their repair work. The San Jose location was established in 1979 to perform concentrated, authentic repairs (major repairs)*, including full instrument disassembly and reassembly. Prior to this, major repairs of endoscopes had been performed at small service locations distributed throughout the U.S. However it was decided that a centralized location where high quality repairs coexisting with rapid repair turnaround was critical for the U.S. market. The centralization of major endoscope repair in one facility has improved both the quality and the efficiency of delivering repair service to our customers.
*Major repairs: An overhaul involves the dismantling, inspection and repair of malfunctioning equipment

Repair Quality on a Level Equal to New Products

Endoscopes, which are inserted directly into the human body, must meet strict safety and performance standards. This applies both to new instruments and instruments being returned to healthcare professionals following service. Therefore, it is required that fully repaired items have the same level of quality as new products. "Safe, stable use" is one of the essential values of endoscopes. With this kind of thinking, Olympus has continued to strive to enhance its service system, ever since the start of the endoscope business in 1952. Currently, Global Network Olympus service locations spread across 6 continents: North America, South America, Europe, Asia, Australia, and Africa. This is the largest network of service sites for any global medical device manufacturer.

III Manufacturing Technology Craftsmanship for Meeting Physician Needs



The current trilateral approach of North America, Europe, and Japan/Asia is supported by the following manufacturing centers. Surgical devices are manufactured in North America based at the three manufacturing facilities. The main products are surgical devices for ear, nose and throat and surgical energy devices. In Europe, rigid endoscopes, therapy devices for urology / gynecology, surgical energy devices and endoscope related equipments are manufactured in Germany, Czech Republic and UK.

Strength in advanced manufacturing technology

Manufacturing in Japan and Asia is based around the three Japanese factories in Aizu, Shirakawa, and Aomori, and the factory in Vietnam. The factories in Japan develop and manufacture gastrointestinal endoscope systems from basic components and have a unique strength in manufacturing that requires a high level of precision and one-of-a-kind know-how assembly expertise on the part of the manufacturing staff. The endoscopes in Olympus flexible endoscopy systems are manufactured exclusively at the Aizu factory. For the main components of the endoscope, such as the imaging unit, control section and electrical connector, there are plans to unify development and manufacturing and to isolate and develop essential key technologies, while realizing high-mix, low-volume production. For example, Olympus decided to develop the machining equipment necessary to manufacture the stainless steel distal tip of the endoscope in-house, thus keeping this knowledge within the company. Products manufactured by the Shirakawa factory include video processors and light sources for endoscopes, ultrasound endoscopes, and capsule endoscopes. The strengths here are component technologies for electrical equipment (including semiconductors and circuit boards), circuit design, and quality assurance. By employing "Toyota production methods," quality improvements are being made daily and production lead times are dramatically shrinking. The Aomori factory features high-tech production of Endotherapy devices. The factory specializes in therapeutic devices such as electrocautery snares for gastrointestinal polypectomy, devices for use in biliary ducts, etc. The Vietnam factory, which was established as a satellite factory of the Aomori facility, also produces Endotherapy devices and related products.

Characteristics of Endoscopy System Manufacturing Techniques That Realize High-Mix, Low-Volume Production

The number of different variations of endoscopes we offer grows each year, and we currently offer more than 300 different models of endoscopes. Creating endoscopes requires sophisticated manufacturing technologies as well as high-mix, low-volume production systems. On top of fulfilling these requirements, we have maintained a stance toward production that compels us to develop components and equipment ourselves should the market be unable to supply us with items that meet our expectations for craftsmanship. As the components of endoscopes have incredibly intricate structures, it is impossible to find ready-made blades for their production. Therefore, each time we need to develop new endoscope components, we start by creating custom blades and other tools capable of meeting our design specifications. The unique products Olympus offers are the result of an ongoing, comprehensive process of in-house craftsmanship, which entails resolving issues on our own. This thorough process has enabled us to earn the trust from the world that we hold today.

Detailed eye for customer needs

High-Mix, Low-Volume Production

In-house development of materials, capabilities, and crafted components not otherwise available

High-precision crafting technologies that create components accurate to the micron

Japanese assembly technologies that make fine adjustments based on combinations of various technologies and expertise

High-precision endoscope tips

High precise scope assembly process

Special Interview: Further Progress in Endoscopic Medicine

Professor, Department of Innovative Interventional Endoscopy Research, the Jikei University School of Medicine
President, Japan Gastroenterological Endoscopy Society

Hisao Tajiri

1976: Graduated from the School of Medicine, Hokkaido University
1976: Postgraduate professional training at the 2nd Department of Internal Medicine, Hokkaido University Hospital
1977: Department of Internal Medicine, Cancer Institute Hospital
1981: Endoscopy Division at National Cancer Center Hospital in Tokyo
1990: Assistant Professor, Department of the 2nd Internal Medicine, National Defense Medical College
1995: Chief of Endoscopy Division, National Cancer Center Hospital East in Chiba
2001: Professor, Department of Endoscopy, the Jikei University School of Medicine
2004: Vice-Director, the Jikei University School of Medicine Hospital
2005: Chairman and Professor, the Division of Gastroenterology and Hepatology, Department of Internal Medicine, the Jikei University School of Medicine, Tokyo
2012: Chairman of Internal Medicine, the Jikei University School of Medicine
2015: Professor, Department of Innovative Interventional Endoscopy Research, the Jikei University School of Medicine (current position)

Notable involvement in academic associations, etc.
President, Japan Gastroenterological Endoscopy Society; Director, Organization of Japan Digestive Disease Week (J-DDW); Vice President, Asia-Pacific Society for Digestive Endoscopy (APSDE); Director, The Japan Society of Adult Diseases; President, Japanese Association for Capsule Endoscopy; Auditor, The Japan Society for Portal Hypertension; Representative Administrator, Japan Consortium for Advanced Surgical Endoscopy (J-CASE); Trustee, Japanese Gastric Cancer Association, and other positions

Q: Of all the different medical devices out there, why is it that the gastrointestinal endoscope has made such progress?

A: In the history of endoscopy, clinical applications began with the development of the gastrocamera in the 1950s, and the 1960s were characterized by use of the technology for careful observation to ensure that nothing had been missed. Subsequently, a series of new instruments, including fiberscopes and electronic scopes, were developed at 10 to 20 year intervals together with advances in the study of endoscopic diagnosis and treatment. Along with the ongoing development of these instruments and the establishment of diagnostic theory, this marked a major advance into an era where it was possible to go beyond the passive "looking" practices of the past to instead proactively observe lesions from a variety of perspectives and then treat them. My own involvement with endoscopes began in the era of the fiberscope. Compared to diagnostic procedures using other medical instruments, the great advantage of endoscopes lay in things like enabling more accurate diagnosis through the taking of biopsies, and minimally invasive therapy such as the use of endotherapy instruments to remove polyps.

Nowadays, roughly 30 years since electronic scopes were first developed, it is possible not only to diagnose whether lesions are benign or malignant, but also to make on the spot treatment decisions based on factors such as their size, depth, and how atypical they are.

In particular, looking back over the innovations of the last decade and focusing on the characteristics of electronic scopes in particular, new diagnostic methods and principles have become available thanks to image enhancement systems now in clinical use that not only provide more natural-looking images but also use the wavelength of light best suited to the purpose. Olympus's Narrow Band Imaging (NBI) technique is a notable example. Its widespread adoption has led to dramatic advances in the endoscopic field by enabling detailed examinations to be performed from observation of fine capillaries in tissue linings, something that was difficult to achieve in the past, and this together with a large amount of evidence has been a spur to international standardization.

In this sense, the most significant aspect of the adoption and development of endoscopes is that progress in both early diagnosis and minimally invasive therapy have occurred in tandem.

Q: With most advances in things like medical instruments or diagnostic and treatment methods having taken place in Europe and U.S. how is it that Japan has been the center for development of gastrointestinal endoscopes?

A: Japanese companies, including Olympus, account for nearly 100% of the development and manufacture of gastrointestinal endoscopes for the global market. In addition to possessing this overwhelming technological base, ever since the time of the Gastrocamera Society, the forerunner of the current Japan Gastroenterological Endoscopy Society, I believe Japan has been the only place in the world where vendor company engineers and the physicians who founded the practice of endoscopy jointly established industry study groups to learn from each other and work together on the development of technology for new endoscopes, and to make the effort to get them into practical use.

As in my own case, I was constantly talking to engineers from vendor companies about such questions as what sort of devices would be needed next and what sort of improvements and enhancements should be made. I believe that it is this long-standing contest of ideas that has led to the progress we have achieved to date.

I had the opportunity to visit Olympus's endoscope factory at Aizu in Fukushima Prefecture. I was able to observe how the workers build their instruments largely by hand, spending all day looking through microscopes as they assemble them piece by piece with micron-level accuracy from components such as lenses, screws and fibers. This left me with an appreciation that it is Japan that possesses the advanced manufacturing techniques needed to build endoscopes, and I felt very grateful for this feeling that I was seeing the true "spirit of the endoscope".

In addition to advanced manufacturing techniques built up over many years, I also believe that the way the Japanese character underpins craftsmanship is also closely linked to the fact that, historically, the development of endoscopes has taken place primarily in Japan.

Q: While gastrointestinal endoscopes have already advanced considerably, are there still areas for improvement?

A: Endoscopes in the past have primarily been directed at the early diagnosis and minimally invasive therapy of cancer, and the latest models have certainly succeeded in delivering detailed images with high resolution. Nevertheless, I can see a lot of issues still to be resolved. These include further improvement to the ease of scope insertion and operation. Looked at from the patient's perspective, there remains a need for minimally invasive endoscopes that produce as little discomfort as possible. In other words, because this requires endoscopes to be thinner and smaller while also providing high resolution and sufficient viewing angle to prevent lesions hiding in blind spots, and also to improve treatment functions, there is a need for manufacturers to develop more advanced technologies and manufacturing techniques.

Another example would be new types of endoscope that use advanced imaging techniques. Using the enlargement function and NBI, it is becoming possible to recognize as to whether a 2-mm lesion visible to the naked eye is benign or malignant. If new endoscopes can be developed in the future that incorporate imaging techniques capable of performing diagnosis in real time at the molecular rather than the millimeter level, it should be possible to achieve early diagnosis and minimally invasive therapy that can truly be said to combine diagnosis and treatment. As this will require progress in imaging technology, I see it as an area where technologists at vendor companies can make a major contribution.

Q: From a medium- to long-term perspective, what technologies are you looking for in the next generation of gastrointestinal endoscopes?

A: Looking back over the history of endoscope technology, innovations in their therapeutic use have occurred at roughly 15 year intervals, including polypectomies in the 1970s, EMR in the 1980s, and ESD in the 2000s. So, given that it is already about 15 years since the development of the last innovation, ESD, I believe we are due for a safer and more effective new technology to provide us with a new development. Endoscopic treatments that utilize robotics, for example, have the potential to fulfill this role.

Robotics does not mean introducing a robot into the human

body to perform a procedure. Rather, it means using the technology to assist in achieving more accurate and detailed movements in accordance with the intentions and actions of the physician operating the endoscope. I believe this will make therapeutic procedures even safer and more advanced.
However, there remain some major challenges to overcome before new technologies like this can be commercialized and enter widespread use. While new endoscopy techniques in the past have always been developed through industry-academia partnerships between doctors like myself and the engineers from vendor companies, I believe it will be important in the future to also include government involvement from the likes of the Ministry of Health, Labour and Welfare, and to engage in a forthright exchange of views. To bring forth new innovations from Japan, I hope to see industry, academia, and government working together, with broad-ranging debate on topics such as deregulation and insurance funding, and the smooth introduction into practical use of new endoscopes incorporating the next generation of technologies.

Q: What factors are being considered for implementing standardization at the international level so that gastrointestinal endoscopes can achieve even wider use?

A: For endoscopes to be used for early diagnosis and minimally invasive therapy throughout the world, I believe it is important that international standardization and the training of endoscopists both proceed in parallel, in emerging nations as well as in the developed nations of Japan, Europe, and U.S. Working toward the earlier detection, diagnosis of cancer and effective minimally invasive endotherapies require the setting up of accurate and efficient screening programs and progress on standardization work aimed at establishing global standards. As a first step in this direction, the Japan Endoscopy Database (JED) has been launched as a new initiative in Japan. This aims to help improve the quality of healthcare and provide patients with the best possible care through the collection and analysis of the endoscope-related skills and treatment data that have been built up by Japanese research institutions, which are world leaders in endoscope diagnostic and treatment techniques. I believe this world-first initiative has the potential to deliver major benefits, not only to patients but also to healthcare providers.
Together with this work on standardization, I also hope to see even greater efforts being made on endoscope training, including initiatives such as holding joint symposiums with participants from Europe, U.S. and emerging nations, and hands-on courses in collaboration with academic societies in Asia and elsewhere.

Q: What are you looking for from Olympus?

A: What the mission of Olympus medical business and the philosophy of doctors like myself have in common is the delivery of benefits to people through advances in medicine. Doctors are continually striving to find ways to use endoscopy medical devices to set up screening programs that can identify high-risk patients at an early stage, or how we can provide minimally invasive therapy. In other words, I believe it is important to maintain an attitude that recognizes that endoscopic medicine does not belong to doctors, nor to the companies that manufacture medical instruments, but rather is intended for the benefit of patients. Accordingly, what I want to see is for Olympus to continue working conscientiously with doctors on technical innovations, developments, and enhancements that can make endoscopic examinations and treatments that are better for patients.

Gastrointestinal Endoscopes

Engineer Interview: Early Diagnosis Made Possible by Endoscope

Division Manager, Medical Product Development Division 1, Olympus Corporation

Hidenobu Kimura

Leading the world by producing the first practical gastrocamera in 1950, Olympus has a 70% share of the global market for gastrointestinal endoscopes and continues to deliver value through the early diagnosis of cancer. In this article, Hidenobu Kimura, a head of development, talks about the importance of the early diagnosis made possible by endoscope, the background to the development of new products, and the future of the Olympus medical business.

To Reduce Cancer Deaths

Q: To begin with, what is so important about early diagnosis in healthcare?

A: In simple terms, its significance lies in its ability to reduce the number of patients who die from cancer. Cancer places such a heavy burden not only on the patient but also on family members who support him/her. In my view, the biggest benefit of early diagnosis is better quality of life (QOL) of the patient and his/her family.

Another major benefit is that it cuts medical costs. Given the rising cost of social security due to the aging of the population, the cost savings provided by early diagnosis are also very significant.

Q: Have people always understood the importance of early diagnosis?

A: Yes. I believe its importance has been appreciated ever since the first prototype gastrocamera was produced and practical endoscopy was born in 1950. In those days, doctors must have seen large numbers of stomach cancer patients pass away without being diagnosed, and I suspect it was a desire to help these patients that led people to seek early diagnosis.

Q: There are various ways of achieving early diagnosis other than endoscopy, such as blood testing for example. What advantages does endoscopy offer compared to the other options?

A: In the past, for example, an X-ray test was accepted as the standard method for diagnosing stomach cancer. Unfortunately, however, it is not easy to detect small early-stage tumors by X-ray, and treatment of a tumor that was found by X-ray can cause a lot of stress on the patient. As well as facilitating early detection by enabling easier detection of minute abnormalities in mucosas, endoscopes made the treatment procedure easier for the patient.

Also, endoscopes allow a doctor to collect samples of the tissue he/she is viewing. This is another major advantage as a pathologist can examine the sample to make an appropriate diagnosis.

Q: Given the benefits of early diagnosis, does this mean that we need to get more people to undergo endoscopic examination?

A: That's right. I lost my aunt to colon cancer. I tried to convince her to get an endoscopic examination every time I saw her, but she wasn't inclined to do so. I believe that a large number of people miss an opportunity for early diagnosis and die from cancer unnecessarily. It means that, in addition to developing endoscopes, it is also vitally important that we raise public awareness of the importance of early diagnosis.

Another factor, I believe, is that many people are reluctant to undergo an endoscopic examination because they worry it will be painful or very expensive. This makes it important to spread facts about endoscopy, such as that the level of discomfort in modern endoscopy is reasonably low, and how much it is likely to cost and under which circumstances the procedure will be covered by health insurance, through awareness raising activities.

Development through Collaboration with Doctors

Q: Olympus currently has more than 70% of the global market share for gastrointestinal endoscopes. What is it about Olympus products that have made them so widely accepted?
A: To begin with, one reason is that Olympus was the first company to produce a practical gastrocamera, and has been working with doctors ever since to make further developments. Endoscopes are devices that require very precise operation and our products were made available through a steady stream of incremental improvements in consultation with doctors over many years. I believe this is why our products have been chosen over those of our competitors.
Q: Endoscopes have evolved over time through continued improvements. During this process, in what respects have major changes been made?
A: There have been two major changes. The first was the shift from gastrocameras to fiberscopes. The transition from fiberscopes to videoscopes was also seen as a significant innovation.
In the days of gastrocameras, photographs had to be taken inside the stomach sight unseen, and diagnosis performed subsequently by viewing the photographs. With fiberscopes, it became possible for doctors to view the interior of the stomach directly. This meant that, if a suspicious location was found, the doctor can examine it more closely or collect a tissue sample.
The appearance of videoscopes, meanwhile, allowed more than one person at a time to view the images. This was a significant improvement. For example, a specialist could instruct a young doctor at the same time as performing a diagnosis. Similarly, doctors with different expertise could view and discuss images in real time This made a major contribution to the progress of medicine by improving the accuracy of diagnosis and the skills of endoscopists.

Key Concepts are Ease-of-Use, Enhanced Diagnosis Capability, and Reliability

Q: Can you tell us about the latest endoscope systems? The EVIS EXERA III targeted at overseas markets and the EVIS LUCERA ELITE for Japan recently became available on the market. What specific objectives were you seeking to achieve in their product development?
A: The three key concepts that we targeted were ease-of-use, enhanced diagnosis capability, and improvement of reliability.
Ease-of-use is extremely important and is a field in which doctors' expectations are getting higher. The new endoscopes include the Narrow Band Imaging (NBI) function that was introduced on earlier models and has received very favorable feedback. The light used for NBI is restricted to a narrow band of wavelengths compared to conventional illumination, accordingly, the total amount of light emission was reduced. This naturally resulted in darker images and prompted requests for a brighter images to make the function easier to use. While this posed a difficult challenge because the darker images were the inevitable result of the physical process, the engineers came up with ideas for overcoming it.
Q: In other words, Olympus proprietary NBI technology has evolved in terms of its ease-of-use. The next objective was enhanced diagnosis capability. Does this mean improvement of diagnostic performance?
A: Yes. It is about how we can achieve better image quality. Our previous series of endoscopes was the first to include high definition imaging, although only on some of the high-end models. We received positive feedback about this function from many doctors who praised it for providing exceptionally clear images, and with this came requests that it be included on a wider range of products, and on thinner endoscopes in particular. As a result, we set a development target of including high definition on all standard models in the new product group.
A problem that arises when moving to higher image resolutions is that things that were not visible in the past are now able to be seen, such as minor scratches in the lens or small specs of dirt, and these small imperfections tend to stand out in the clear images. Accordingly, we asked the manufacturing departments whose responsibilities include things like lens grinding and quality assurance to develop technologies and equipment for producing high-quality parts and assembling them into products, as well as inspection machines and standards for checking quality.

Q: What does reliability improvement mean in practice?
A: It means ensuring that the endoscope does not fail, and that it can perform appropriate examinations whenever needed. In the past, endoscopes had to have waterproof caps plugged into their electrical connectors when they were being chemically disinfected after use. Unfortunately, there were cases when busy nurses or endoscopy technicians forgot to do this, resulting in the failure of the endoscope. Designing an endoscope that is easy to disinfect without the waterproof cap makes it more convenient for nurses and other staff to handle endoscopes and saves repair cost for the hospital. One of our aims for development of the new endoscopes was to make them fully waterproof. During development, When we asked many Nurses and endoscopy technicians about their opinion during the product development stage, we received a very positive response.

Potential of Endoscopic Procedure

Q: What do you think we can expect from Olympus in terms of future developments in endoscopic diagnosis?
A: While gastrointestinal endoscopes have been developed for the early diagnosis of cancer, in practice we see them as being an even more versatile medical device. For example, per-oral endoscopic myotomy (POEM) is a surgical procedure that has been developed for using an endoscope to diagnose and treat dysphagia of the esophagus (difficulty swallowing). This involves an endoscope being used to identify and treat a dysfunction rather than cancer. In the future, I believe we can expect to see more of this sort of expansion of endoscope application.
Q: Regarding the future, can you tell us more about the use of endoscopic examinations in emerging countries? I understand that endoscopes have yet to enter widespread use in such parts of the world.
A: That's right. While endoscopic examinations as such are used in emerging countries, the issue is that access to such examinations has not yet become available to wider populations. This means that patients continue to die due to a failure to perform adequate diagnosis at an early stage.
I believe that Olympus has a mission to help these people. We have been working hard to have endoscopes adopted more widely, through establishment of training centers in Thailand and China to teach doctors how to use endoscopes, and having our subsidiary in India provide comprehensive support.
When I served as an interviewer during the recruiting process, I asked one student why he wanted to join Olympus. He said that, given the world's population of seven billion, Olympus with a 70% market share was responsible for the health of five billion people and that was why he wanted to join and become involved in the Olympus medical business. The student reminded me of the weighty responsibility of what we do. It is not just enough to work on technical development to address issues in front of you; rather you have to keep in mind the need to think carefully about how we can provide endoscopes that will contribute to people's health in any part of the globe.
Q: While Olympus may have a 70% share of the global market, developed economies such as Japan, Europe, and U.S. currently make up the bulk of this market. This means that you now need to go after a 70% share of the entire world's market, including emerging countries.
A: We do. Naturally, I believe that we need to work on product features that will expedite wide spread acceptance and use of endoscopic medicine, and also on maintaining good communications with doctors in all parts of the world. It may be that we will need to take endoscope development in quite different directions from our current products. I expect that dealing with emerging nations by taking steps to understand these sorts of practical requirements will be of particular importance in the future.

The History of Endoscopy and Olympus

Roots in Ancient Greece

"I want to view the inside of a human. I want to unravel the mysteries of life."
Since ancient times, there has been a quest to find a way to observe the inside of the human body. This history dates back to the 4th century BC, back to ancient Greece and the time of Hippocrates, the father of medicine. Back then, horses were an important mode of transportation, and many people developed hemorrhoids from riding them. By using a device to observe the interior of the anus, the hemorrhoids were able to be healed by burning. This is said to be the origin of the endoscope.
Coming forward through time, modern endoscopes began with the "Light Conductor," made in 1805 by the German physician Philipp Bozzini. It looked like a lantern, and worked by inserting a metal tube into the urethra, rectum, or pharynx. The light of this special lamp was then used to make observations.

Named the "Endoscope" in France

In 1853, the French physician A.J. Desormeaux created a device for observing the urethra and bladder. This was the first time the term "endoscope" was used.

Examinations with Street Performers

The first person in the world to successfully observe the stomach was the German physician Adolph Kussmaul. In 1868, expanding on Desormeaux's endoscope, he fashioned a metal pipe with a length of 47 cm and a diameter of 13 mm in his medical equipment shop, and performed an examination on a sword-swallower.
However, the amount of light that the lamp produced was insufficient, and he was unable to adequately illuminate the inside of the body. It was therefore necessary to wait until the introduction of electric lighting to have a practical endoscope.
In 1879, the Germany physician Maximilian Nitze and the Austrian electrical engineer Joseph Leiter made a cystoscope using an electric light as the light source. They afterwards continued on to construct an esophagoscope and a gastroscope. In 1881, the Polish physician Jan Mikulicz-Radecki, with the help of Leiter, created a rigid gastroscope where the first third of the tip was curved.
The first practical gastroscope appeared in 1932. It was the flexible gastroscope developed by German physician Rudolf Schindler. It had a length of 75 cm, a diameter of 11 mm, and a third of the tip was curved slightly. However, since this endoscope was essentially a metal tube that was inserted into the body, the procedure was painful for the patient, and there was a possibility of accidents, such as perforation of the GI tract. Prior to WWII, their use was limited only to parts of Europe and Japan.

The Idea of the Gastrocamera

However, the idea of a stomach camera that has an ultra-small camera attached to the tip of a flexible tube and which could take pictures inside the digestive tract emerged in Europe and the U.S. at the end of the 19th century. In 1898, the developments of two German physicians, Lange and Meltzing were presented, but as the images obtained were blurry, they proved to be impractical.

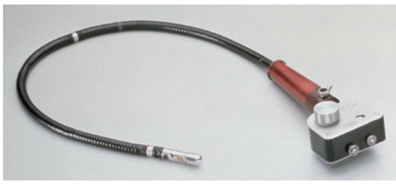
Olympus: World's First Practical Gastrocamera

The first company in the world to succeed in making a practical gastrocamera was Olympus. In 1949, with the request of Dr. Tatsuro Uji (Department of Surgery, the University of Tokyo Hospital Koishikawa Branch) that, "I somehow want to cure the gastric cancer that afflicts so many Japanese people," the Olympus technical team began development of a gastrocamera. After developing numerous essential technologies such as a miniature lamp to illuminate the inside of the stomach, a wide angle lens to capture a large field of view, a device for winding the film, and choosing materials to construct the flexible tube used to

The "Biological Father" and the "Foster Father" of the Gastrocamera

At the department of surgery, the University of Tokyo Branch Hospital, with the support of Assistant Professor Takeo Hayashida, Dr. Uji and the Olympus technical team developed an experimental gastrocamera. This gastrocamera was launched in 1952 as the "GT-I Gastrocamera." However, as there were a number of problems with the early product and imaging techniques had not been well established, it did not catch on. Gastrocamera operations ran a deficit, and there were discussions at Olympus as to whether the business could continue on as it was.
Amid this, the first place to recognize the potential of the gastrocamera and make an effort to popularize it was the #8 Research Laboratory of the University of Tokyo Main Hospital First Department of Internal Medicine (Tasaka Internal Medicine Department: Professor Sadataka Tasaka).
The Tasaka Internal Medicine Department first assisted Olympus by offering advice regarding problems with this early instrumentation from a user's point of view. But the greater topic at the time was the need to establish a standardized technique for photographing the inside of the stomach. The gastrocamera differs from the fiberscope in that the doctor cannot directly observe the inside of the stomach during the examination. It is exceedingly difficult to get a satisfactory image while blindly maneuvering the instrument around inside the

Dr. Uji (center), attending a clinical trial



The world's first practical gastrocamera

Fiberscope

inserted the miniature camera into the patient, they succeeded in developing a prototype in 1950. They continued their aggressive work with doctors in order to improve the device, and in turn physicians worked on rapidly developing techniques for diagnosing ailments of the digestive organs.

Introduction of the Fiberscope

However, there was a problem with the gastrocamera. Unlike the gastroscope, it could not view the inside of the stomach directly, in real-time. The device blindly took photographs of the stomach's interior and the film had to be processed before the doctor could see what the gastrocamera saw. What solved this problem was the development of the fiberscope, introduced in 1957.

In 1964, already having a gastrocamera capable of taking sharp photographs of the stomach, Olympus released a gastrocamera with a fiberscope attached. This combined instrument allowed the doctor to both observe the stomach in real-time and to take high-quality photographs for documentation. Olympus' reputation in the medical field grew.

A fiberscope is made up of tens of thousands of optical fibers, each fiber with a diameter of 8 microns, a width approximately 1/10th that of human hair. As the image is transmitted optically, the endoscope itself can bend. As doctors were now able to directly see inside the patient's body, techniques necessary for examination became easier, and the fiberscope's popularity quickly spread. The diagnostic area also expanded to the esophagus, duodenum, large intestine, bronchial tubes, and bile ducts.

Furthermore, the real-time image of the fiberscope created the ability to perform medical therapy through the endoscope, which proved to be a tremendous advantage. By inserting devices through a forceps channel and performing surgery on a tumor while looking inside the body in real-time, minimally invasive procedures became possible, reducing the doctor's reliance on the surgical scalpel.

Videoscope System

Toward a New Era with the Videoscope

In 1983, the videoscope was initially introduced in the U.S. While this first instrument was ground-breaking, Olympus' own initial offering, released in 1985, was seen as a significant improvement. A videoscope has an imaging element such as a charge coupled device (CCD) built into its distal tip. The image captured by this sensor is converted to a video signal and is then displayed on a monitor for all in the room to see. This allowed for sharing the exam among multiple doctors and healthcare professionals, and diagnostic accuracy increased rapidly.

Following the introduction of videoscopes there continued to be numerous technological advances, such as high-definition imaging, Narrow Band Imaging (NBI) and much more. Videoscopes have dramatically increased the endoscope's diagnostic and therapeutic potential.

stomach.

In order to determine the location of the gastrocamera in relation to the various parts of the stomach, various daunting tasks had to be repeated, such as using x-rays and recording the gastrocamera's degree of insertion, twisting of the shaft and noting the result, and measuring the amount of air flow required to optimally insufflate the stomach. Through these experiments, a standardized imaging technique was established around 1956.

The role of the "Gastrocamera Research Group" (currently the Japan Gastroenterological Endoscopy Society), as first established and centered around the Tasaka Internal Medicine Department, cannot be forgotten. The first meeting of the Gastrocamera Research Group was held in 1955, and research reports focusing on cancer were presented. At the fifth research society meeting in 1958, there were 16 presentations and 200 attendees, and research had progressed to the clinical stage.

Along with Olympus as the manufacturer, the group established the Technology Committee (afterward the Gastrocamera Promotion Committee) in 1955. Once a month, they met to share opinions regarding failure prevention and device improvements. These efforts became the driving force behind the spread of the gastrocamera.

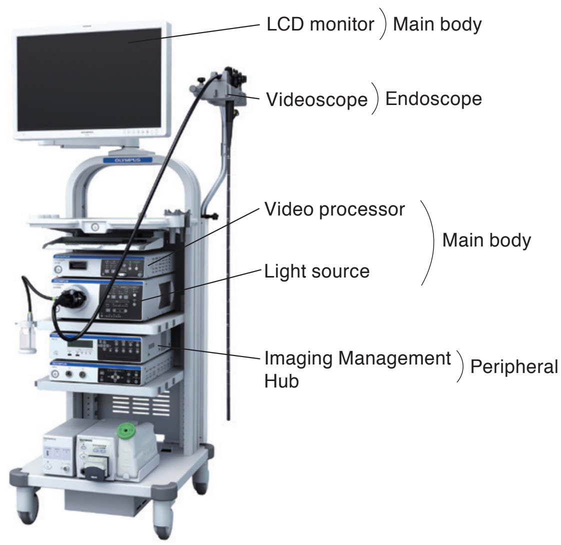
First Gastrocamera Research Group meeting (at the podium, Professor Tasaka)

It can thus be said that, if the University of Tokyo Branch Hospital Department of Surgery was the "biological father" of the gastrocamera, then the Tasaka Internal Medicine Department would be its "foster father."

Structure and Components of Endoscope

Endoscope Types

Endoscopes can be broadly divided into two types: those that are inserted into the natural openings in the body, such as the mouth, nose, anus, vagina and urethra and those that are inserted through a small surgical opening made on the surface of the body. The former are mainly used by physicians, and the latter by surgeons. The world's first practical gastrocamera created by Olympus (as well as all gastrointestinal endoscopes which followed) falls in the former group and are used primarily by internal medicine personnel.



Videoscope system

Outline of Endoscope System

Current gastrointestinal endoscopes for examining the esophagus, stomach, and large & small intestines are mostly videoscopes.
Videoscopes have an electronic imaging sensor (usually a CCD) attached to the distal tip of the instrument. A videoscope consists of : 1. The endoscope that is inserted into the mouth, anus or other orifice and observes the inside of the body, 2. The main body, which supplies light, air, and water to the endoscope and displays the image, and 3. Peripheral equipment.

Endoscope Design

The endoscope has three parts: the control section, the insertion section, and the connector section.

Control Section

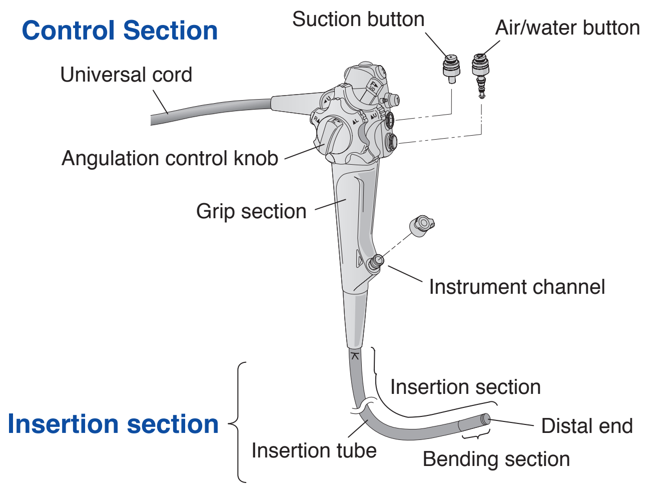
The angulation knob on the control section is connected to the tip of the endoscope by a series of wires. By turning the angulation knob, the bending section at the distal end bends horizontally and vertically allowing for easier insertion into the body and the ability to view 360 degrees within body cavities.
The endoscope also contains buttons (valves) for feeding air or water and for applying suction. Covering the opening in the air/water valve will feed air into the organ being observed and will gently expand it for a better view. Depressing this valve will feed water through the endoscope to wash the viewing lens. Depressing the suction valve will allow the doctor to use the endoscope to suction any fluids which are obscuring a good view of the tissue. Therapeutic instruments can be passed through the instrument channel for performing endoscopic biopsy and other therapies.

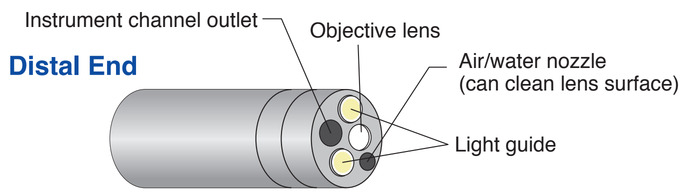
Insertion Section

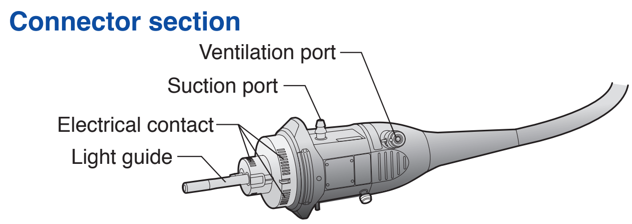
On the tip of the insertion section, there are four main parts: 1. Objective lens and imaging sensor, 2. Light guides that bring light from the light source through the endoscope, 3. Instrument channel outlet where therapeutic tools can be pushed in and out (also the suction opening), 4. Nozzle for feeding water and air.
The objective lens is typically a super-wide-angle lens in order to visualize a large area of tissue at one time. In order to view tumor tissue in a more detailed manner, some endoscopes have an optical zoom feature. Recent models also support high-definition video displays.
Light guide fiber bundles conduct light from the external light source through the endoscope to illuminate body cavities. Instruments are pushed in and out of the instrument channel for harvesting tissue (biopsy), removing tumors, cauterizing bleeding lesions, etc. The nozzle on the distal tip is used to clean the lens with water and expand body cavities by insufflating them with air.

Connector Section

The connector section connects the endoscope with the video processor and light source through the universal cord. Supply of air and water is also performed through this connection.







Outline of Main Body and Peripherals

The main body and peripherals consist of: 1. Video processor, light source, LCD monitor (main endoscopy components), 2. Imaging management hub and other accessories.

The video processor converts the electrical signal captured by the image sensor on the endoscope tip into a video signal and displays the resulting image on the LCD monitor. Recent models also support the capture and display of images with "High-Definition" (HD) image resolution. Current video processors also provide various image processing features such as color enhancement, Narrow Band Imaging, etc.

The light source produces light using a xenon lamp that is very close to natural sunlight in color and sends this light to the endoscope tip through a bundle of optical fibers contained within the endoscope. The light source operates in tandem with the video processor to automatically control the brightness of the image for optimum viewing. A feature of Olympus endoscopes is that they allow for enhanced imaging through advanced optical-digital technologies, one example being Narrow Band Imaging (NBI). Some types of light source also include a pump for feeding water and air.

Imaging Management Hub simplifies the process of recording, managing, and editing high-resolution endoscopic images (video and still images).

Video processor

Light source

Imaging Management Hub

Enhanced Imaging and NBI

The gastrocamera, developed by Olympus in 1950, greatly influenced early-stage gastric cancer diagnostics. Through the accumulated research that followed, it was understood that early-stage lesions could be found through slight differences in the color of mucosal surfaces within the digestive tract.

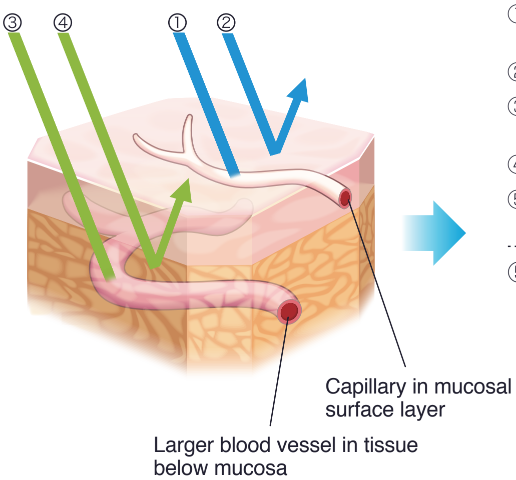
A technique called "chromoendoscopy," spread rapidly starting in the 1970's. This procedure sprays various dyes on the tissue lining the GI tract in order to detect subtle lesions that are hard to detect using normal endoscopic imaging.

Olympus expanded upon these principles and developed a technique called Narrow Band Imaging (NBI) that is designed to reveal subtle lesions through an optical method. NBI is one example of an imaging enhancement technique that uses a combination of optical and digital methods (opto-digital).

NBI (Narrow Band Imaging)

Olympus developed Narrow Band Imaging technology to enhance observation of mucosal tissue. Now with the EVIS EXERA III/EVIS LUCERA ELITE system, an improved version of NBI gives twice the viewable distance and is significantly brighter than the previous system.

NBI is an optical imaging technology that enhances the visibility of vessels and other tissue on the mucosal surface. NBI works by filtering the white light into specific light wavelengths that are absorbed by hemoglobin and penetrate only the surface of human tissue. As a result, with Narrow Band Imaging, capillaries on the mucosal surface are displayed in brown and veins in the submucosa are displayed in cyan on the monitor.



① Blue light : Strongly absorbed by hemoglobin in capillaries near the tissue surface, and not reflected.

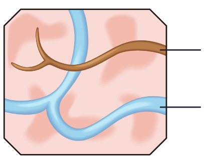
② Blue light : Strongly reflected by the mucosal surface layer.

③ Green light : Strongly absorbed by hemoglobin in blood vessels deeper in the tissue, and not reflected.

④ Green light : Strongly reflected by the tissue beneath the mucosa.

⑤ A well-resolved image is produced by utilizing both reflected and non-reflcted light

⑤ Monitor screen in NBI mode



Main types of flexible endoscope and their intended use

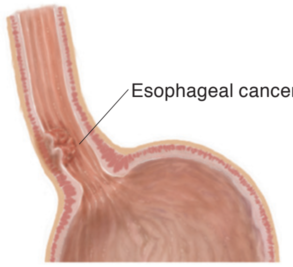
Olympus sells a variety of different endoscopes, each designed to examine a specific part of the body. In this section, we provide information primarily on various types of endoscopes.

Esophagus / Stomach

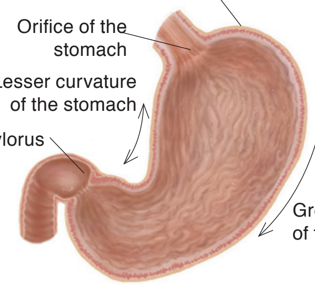
Main diseases

Esophageal cancer : The walls of the esophagus are made from multiple layers of mucosa and muscle. Cancer of the esophagus typically occurs in the innermost mucosa. This is called “squamous cell carcinoma” and over 90% of Japanese people with cancer of the esophagus have this type of cancer. Habitual drinking and smoking are sources of risk. There is another type of esophageal cancer called “adenocarcinoma” which is more common in Europe and the U.S. This type of cancer is found in 60-70% of esophageal cancer cases in Europe and the U.S. The primary cause of adenocarcinoma is a condition called Barrett's esophagus, where stomach acid flows up the esophagus and causes inflammation of the esophageal mucosa. Due to shifts towards a more Western diet, there is a possibility that this type of esophageal cancer may become more common in Japan in the future.

Stomach cancer : It is thought to arise in the mucosas of the stomach from gastritis and atrophy. When atrophy occurs in the mucosas of the stomach, it leads to atrophic gastritis, which can lead to "intestinal metaplasia," a condition in which the stomach-type mucosa turns into intestinal-type mucosa. Intestinal metaplasia is known to develop into cancer. Recently it has been shown that this is related to the bacterium Helicobacter pylori. H. pylori causes inflammation of the mucosa in the stomach and has been observed to lead to atrophic gastritis and intestinal metaplasia.



Esophagus



Stomach

Endoscopes

Gastrointestinal Videoscope : Gastrointestinal videoscopes are for viewing the stomach and duodenum through the esophagus and usually have an insertion tube length of 1,030mm. Videoscopes have a forward-facing lens on the distal tip which is ideal for observing tissue directly in front of the endoscope. Videoscopes designed to be inserted through the mouth typically have an insertion tube diameter of around 10 mm; videoscopes designed for passage through the nose are about half that diameter.

Gastrointestinal Videoscope

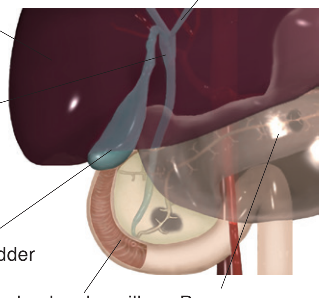
(From left) diameter
5.4mm, 8.9mm, 10.2mm

Biliary Tract / Pancreas

Main diseases

Gallstones : The most frequent case is the formation of stones in the biliary tract*. Gallstones that form in the gallbladder are particularly common. Cancers that occur in the gallbladder or bile duct are referred to as “biliary tract cancers.” They are divided into “gallbladder cancer” and "biliary tract cancer" depending on where they develop. It is believed there is a relationship with biliary tract stones (gallstones). If gallstones injure the biliary tract, they can cause inflammation, which is believed to cause cancer over a long period of time.

*Biliary tract : general term of hepatic duct, gallbladder, major duodenal papilla



Pancreatic cancer : It comes from pancreatic cells. Pancreatic cancer is divided into two types: exocrine (digestive enzyme secretion system) and endocrine (hormone secretion system). About 95% of pancreatic cancer is of the exocrine type, and about 85% of these are invasive pancreatic duct cancers that occur on the epithelium of the pancreatic duct. Pancreatic cancer typically occurs in 50-70 year olds, especially in elderly males.

Endoscopes

Duodenovideoscope : Unlike gastrointestinal videoscopes and colonovideoscopes, duodenovideoscopes have a side-viewing tip design in which the lens and illumination optics are on the side of the scope. This enables the instrument to perform procedures such as Endoscopic Retrograde Cholangio Pancreatography (ERCP) that is imaging of the pancreaticobiliary ducts via the duodenum, and for performing Endoscopic Sphincterotomy which allows removal of gallstones via the mouth. This endoscope has a prism at its tip to allow it to look perpendicular to its axis, and a forceps elevator to deflect accessory devices in the same direction. Duodenovideoscopes typically are 1,240mm long.

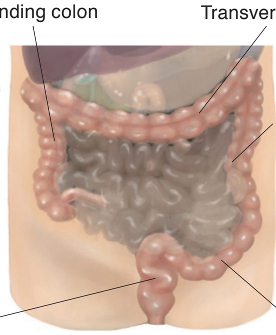
Duodenovideoscope

Side-viewing tip design
(including forceps elevator system)

Large Intestine

Main diseases

Large intestine cancer : It is increasing in Japanese people as they are starting to eat a more Western diet. Cancer of the large intestine includes both colon cancer and rectal cancer, but colon cancer especially is increasing rapidly. Consuming animal fats causes greater secretion of biliary acid to help with digestion. There are carcinogens among the substances that develop when digesting fats. It is believed that cancer occurs in the mucosa of the large intestine.
The inside of the large intestine consists of four layers. Sometimes, benign polyps called adenomas occur in the mucosa. Many cases of colorectal cancer are believed to be related to these polyps. Furthermore, it has been recently discovered that there are also flat and depressed cancers that develop directly from the mucosa. The most common areas for colorectal cancer are the rectum and sigmoid colon, which cancers account for about 70% of all cases.



Various parts of the colon

Endoscopes

Colonovideoscope : Colonovideoscopes are longer than gastrointestinal videoscopes in order to accommodate the long 1.5m length of the adult large intestine. Standard-length colonovideoscopes are 1,330mm long. Extended length models are 1,680mm long. The Colonovideoscope has a forward-facing tip. In order to facilitate insertability into the colon a flexibility adjustment ring allows the operator to adjust the stiffness of the insertion section during the procedure. Colonovideoscopes typically have an insertion tube diameter of 12mm.

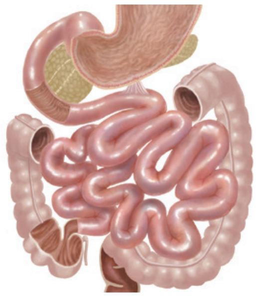
Colonovideoscope

Flexibility adjustment ring

Small Intestine

Main diseases

Ulcer : It is the most common disease of the duodenum. Deep ulcers can cause bleeding. While rare, malignant tumors such as papillary cancer sometimes occur. Diarrhea, abdominal pain, fever and other symptoms that accompany Crohn's disease, an inflammatory disorder, are also seen.



Small intestine and surrounding organs

Endoscopes

Small Intestinal Videoscope : This involves using an endoscope with a balloon attached on the distal end such that the inflated balloon holds the intestine open and allows the endoscope to be moved forward. Insertion can be via either the mouth or anus. As the instrument channel outlet is also provided, as on a conventional endoscope, it can be used for biopsies or to perform simple procedures. To be long enough to view the small intestine, the endoscope has a length of 1830mm and a diameter of approximately 9mm.

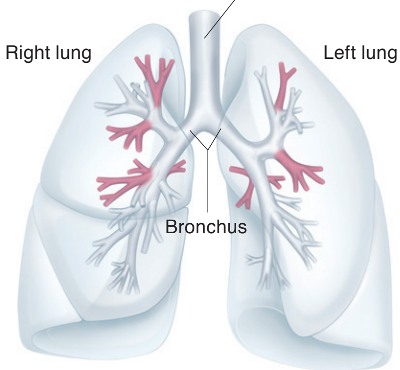
Small Intestinal Videoscope

Single Balloon Enteroscope System

Lungs / Bronchus

Main diseases

Chronic Obstructive Pulmonary Disease (COPD) : A progressive obstruction of air flow (causing breathing difficulty) that comes about as a result of inflammation of the lungs or bronchus due to the inhalation of tobacco or other harmful substances. While new epidermal cells grow in peripheral airways as the body seeks to repair cells damaged by inflammation, the repeated process of inflammation and repair that occurs when the inhalation of harmful substances continues for a long time results in a thickening of airway walls, causing constriction.



Lung

Endoscopes

Bronchoscope : Olympus manufactures three types of bronchoscopes for viewing the lungs and bronchial tubes: videoscopes, fiberscopes, and a "hybridscope" which has both fiber optic and video components. Bronchoscopes may be inserted either through the mouth or the nose and can travel down to examine the smallest lumens of the bronchial tree. Videoscopes have an advantage in obtaining sharp pictures of the lung through their high quality CCDs. Fiberscopes have an advantage in being smaller in diameter at the tip and therefore allow for deeper insertion into the distal portion of bronchial tubes. The hybrid type has a fiberoptic bundle in its tip and a CCD image sensor installed in its control section. This instrument incorporates advantages of both videoscope and fiberscope technology, with high insertability due to its small diameter while at the same time also producing high quality images.


Bronchoscope


Control section

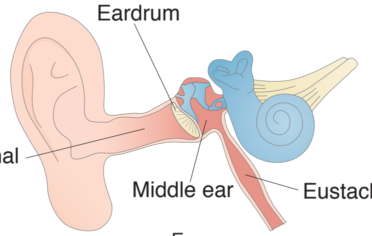
Ear / Nose / Throat

Main diseases

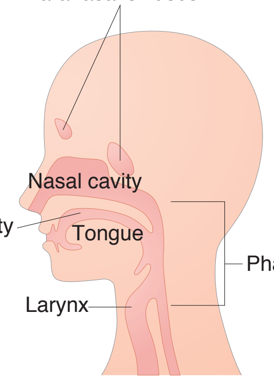
Tympanitis : A condition in which the infection of the middle ear by bacteria, viruses, or other germs due to a cold causes inflammation, resulting in a buildup of pus or fluid. Symptoms include headache, dizziness hearing difficulties, or the ear feeling blocked.

Sinusitis : What is commonly known as empyema is a condition resulting from inflammation of the paranasal sinus due to causes such as a common cold, hay fever, or dental decay. It results in a blocked nose with thick colored mucus. Other symptoms include headache and an impaired sense of smell.

Laryngeal / Pharyngeal cancer : A throat cancer common among men. The symptoms, which include a sore throat and loss of voice are similar to the common cold.



Ear



Nose / Throat

Endoscopes

Rhino-Laryngo Videoscope : Rhino-Laryngo videoscopes are for looking at the ears, nose, and throat. Latest videoscopes mount ultra compact , high-performance CCD, realize great advances in image quality compared with conventional models. They are also able to perform NBI.


Rhino-Laryngo Videoscope


High-performance CCD in the tip

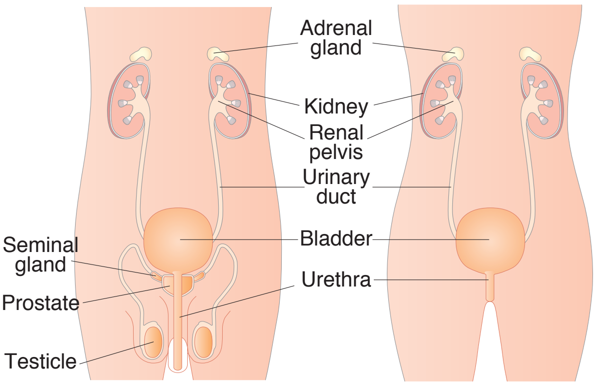
Urinary system

Main diseases

Benign Prostate Hyperplasia (BPH) : A condition in which urination is obstructed by pressure placed on the urethra by an enlarged prostate, which is located under the bladder. Symptoms include a sensation of residual urine and more frequent trips to the toilet due to the reduced amount of urine passed at each urination.

Urinary stone : A condition in which substances contained in urine crystalize for some reason and coalesce in the form of a stone. Typical symptoms include extreme pain, bloody urine, or the presence of the stone in urine. The condition is believed to result from a shift to a more Western diet.

Bladder tumor (cancer of the bladder) : This occurs when the urothelium becomes cancerous. While most cases (90% or more) are categorized as urothelial cancer, rare instances of squamous cell carcinoma and adenocarcinoma also occur. The main symptoms are bloody urine or pain during urination.



Urinary system

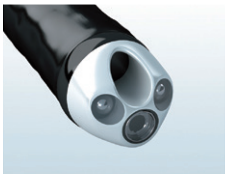
Endoscopes

Ureteroscope / Cystovideoscope : They are used for viewing the urinary bladder through the urethra and the kidneys through the urinary duct. Olympus manufactures both videoscopes and fiberscopes for this application. The tip diameter of these endoscopes range from 3-5mm. The videoscope version supports high-definition imaging due to its high performance CCD and is also capable of NBI. Moreover, in order to facilitate the observation of the bladder neck, the Down side bending angle of 275 degrees and the UP side bending angle of 180 degrees are realized.

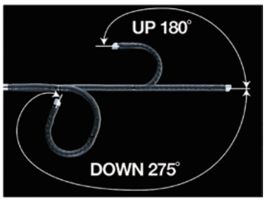
*Rhino-Laryngo videoscopes and ureteroscopes can be used along with Olympus surgical endoscopy systems.

*A resectoscope is a rigid endoscope for viewing and treating the urethra and bladder.

Ureteroscope



Endoscope tip



Flexible bending function

Resectoscope

Ultrasound Gastrovideoscope

In addition to regular endoscopes, Olympus manufactures “ultrasound videoscopes” that allow combined endoscopic imaging and ultrasound imaging of the organ under inspection. These instruments have an ultrasound transducer installed on their tip. By using medical ultrasound technology, lesions that cannot be seen from the surface and are located deep in the organ can be found. In the digestive tract, this kind of endoscope is used to find tumors and cancers hidden below the surface of the GI tract and to examine varices in the esophagus. They are also used to find cancer, gallstones and pancreatic stones in the pancreas and biliary ducts. Biopsy needles inserted under ultrasound guidance can diagnose hidden submucosal tumors and diagnose and treat pancreatic cysts.

Ultrasound gastrovideoscope

Probe (pink area) and aspiration needle

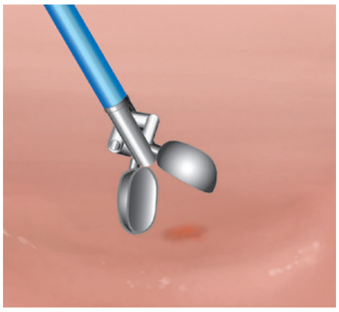
Endotherapy Devices

History of Endotherapy devices

There are two approaches to endoscopic surgery: a medical approach and a surgical approach. The medical approach involves inserting the endoscope into a natural opening of the body, such as the mouth, nose, urethra, or anus, and performing a therapeutic procedure, e.g. resecting a tumor. The surgical approach involves substituting endoscopic surgery in place of an open surgical procedure such as laparatomy or thoracotomy. However, these procedures still require small incisions in order to insert the endoscope itself. The former is referred to as an "endoscopic procedure," while the latter is called "endoscopic surgery." The following devices are used in endoscopic procedures.

Start with Biopsy

One of the earliest and most common procedures performed with endoscopes is tissue biopsy. Olympus introduced a fiberscope to the market in 1966 that contained an "instrument channel." Through this channel a doctor could insert a biopsy forceps and remove a small piece of suspect tissue that could then be examined by a pathologist under a microscope. Endoscopic biopsy greatly streamlined the diagnosis of early-stage stomach cancer.
By 1968, physicians were resecting polyps from the stomach using snares (wire loops), and using biopsy forceps energized with high-frequency electrical current for tissue biopsy coupled with control of bleeding (cauterization).



Biopsy

Big Developments for the Biliary Tract and Pancreas – Late 1960s –

The 1960's saw big developments in endoscopic diagnosis and therapy of the biliary tract and pancreas. Endoscopic Retrograde Cholangio Pancreatography (ERCP) was developed to instill radiographic contrast dye into the pancreatobiliary system. This enabled x-ray imaging to identify tumors, stones, strictures and other problems in the pancreaticobiliary tract. Further developments led to the development of Endoscopic Mechanical Lithotripsy (EML), which uses an endoscopic device to crush and extract gallstones from the biliary tract.

EML

Resecting Lesions on a Wider Scale – 1980s –

Through joint collaboration between doctors and Olympus, Endoscopic Mucosal Resection (EMR) became practical in the 1980's. EMR is a surgical procedure where normal saline is injected under a small patch of early-stage stomach/colorectal cancer, and the cancerous tissue is raised up and separated from the normal tissue below. The cancer is then removed using a snare.
Thanks to new developments in devices, a more radical procedure called Endoscopic Submucosal Dissection (ESD) for removing larger early-stage lesions appeared in 2002.

ESD

Major Procedures Using Endotherapy Devices

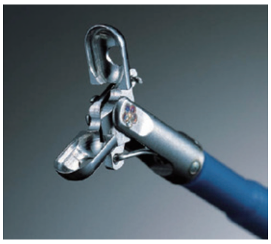
Olympus currently supplies more than 1,000 types of Endotherapy devices. They can be categorized into diagnostic and therapeutic use.

Diagnostic Approach Using Endotherapy Devices

Biopsy

A biopsy is a diagnostic procedure that removes pieces of tissue which is suspected of being a lesion, subject to pathological testing under a microscope. The devices used for this purpose include biopsy forceps. Biopsy forceps include the standard type and also a type with a needle which prevents slipping on the surface of mucosa. Various biopsy forceps are used such as a single-side opening type for the esophagus and the wide-opening type used for stiff mucosa.

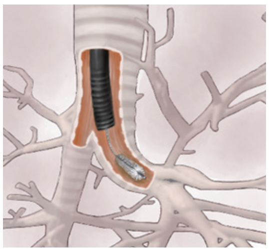
Biopsy forceps with needle



Standard biopsy forceps

Cytology

Cytology is performed by scrubbing a brush over a mucosa to collect tissue. The procedure is used in cases involving bronchial tubes with narrow openings.



Cytology of bronchus

Cytology brush

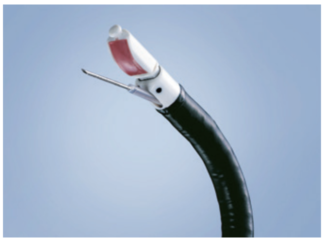
Dye Spraying

In order to identify tumors or other lesions in the early stages, dye, such as Lugol iodine solution, is sprayed on the surface of the mucosa. This procedure enables easier observation of mucosal surface shape change. A spraying tube is used for this purpose.

Spraying tube

Endobronchial ultrasound transbronchial needle aspiration (EBUS-TBNA)

A technique that uses ultrasound to guide the insertion of a needle into the lymph node via the trachea and bronchus for the collection by aspiration of cell or tissue samples for the purpose of diagnosing lymph node metastasis in lung cancer.

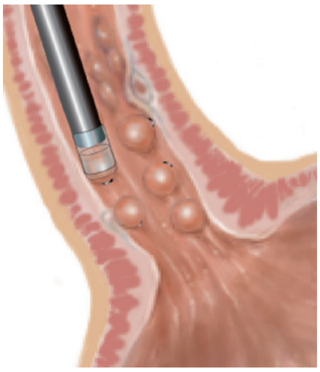


Probe (pink area) and aspiration needle

Therapeutic Procedures Using Endotherapy Devices

Esophageal Varix Therapy

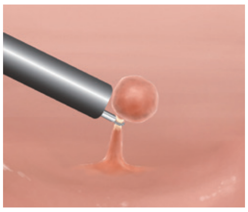
Esophageal varix is a condition in which cirrhosis blocks venous blood and leaves it with nowhere to go, causing a swelling in the veins of the esophageal wall. If the veins burst or bleed, the patient risks death unless some effective treatment can be implemented.
Esophageal varix ligation is a procedure that involves using a snare or rubber band to ligate the vein and stop the blood flow.
Esophageal varix sclerotherapy is a procedure that involves using a needle to inject a sclerosant into the varix to harden and remove with the mucosa.



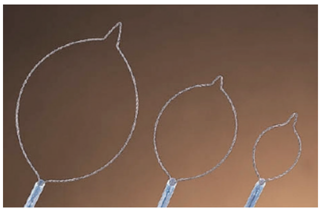
Using a snare or rubber band to ligate varix

Polypectomy

A polypectomy is a procedure that removes local elevated lesions called polyps which grow out of the mucous epithelium. A wire snare is looped around the base of the polyp, and high-frequency electrical current is applied while the snare is tightened. This procedure cuts off the polyp and cauterizes the polyp stump to prevent bleeding. The polyp can then be captured, removed from the body and sent to a pathologist for analysis.



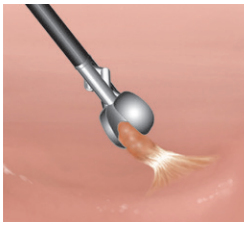
Polypectomy



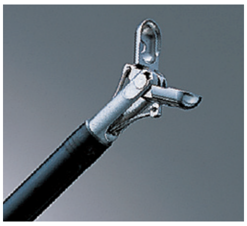
High-frequency snare

Biopsy

For small polyps and relatively flat (sessile) polyps, a procedure called a biopsy can be performed. While pinching the polyp with a biopsy forceps, high-frequency current is used to remove the tissue and cauterize the polyp base, preventing bleeding from the site.



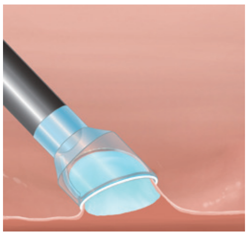
Hot biopsy



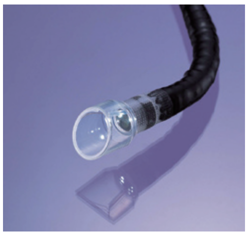
Hot biopsy forceps

EMR (Endoscopic Mucosal Resection)

EMR enables the removal of small flat lesions such as early-stage cancers. There are several techniques for performing EMR. One of these is the "2 channel method." Using an endoscope with two forceps openings (channels), the lesion is first marked, and lesion is then raised by injecting normal saline into the submucosal directly under the lesion. The lesion is then held with grasping forceps while the raised tissue is cut off using a high-frequency snare. The grasping forceps then removes the excised tissue from the body.
Another method is so-called "cap EMR" (EMRC). This procedure uses a transparent plastic cap fitted over the tip of the endoscope. The lesion is first raised by injecting normal saline into the submucosa under the lesion. The raised tissue is then sucked into the cap attached to the tip of the endoscope and is cut off using a high-frequency snare positioned inside the cap. The lesion is then recovered using suction.



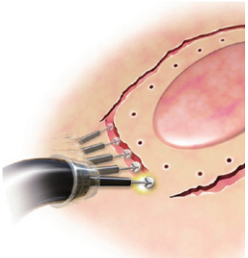
EMRC method



Clear cap

ESD (Endoscopic Submucosal Dissection)

EMR is limited to removing lesions smaller than 2cm. ESD was developed as a procedure for removing much larger (and more irregularly shaped) lesions. First, an electrosurgical electrode is used to make small burn marks to outline the area around the lesion. The lesion is then raised by injecting normal saline into the submucosa to separate the lesion from the normal tissue below. Next, the mucosa around the lesion is cut using an IT Knife. The submucosa is then separated, and the lesion is recovered using forceps. The IT Knife is an electrosurgical cutting electrode with a ceramic insulator attached to its tip. The insulator lowers the risk of perforation in the digestive tract, and also allows for large-scale mucosa removal.

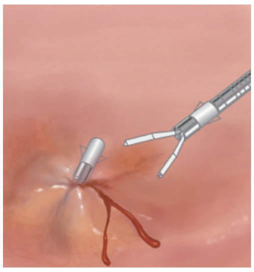


ESD

IT knife

Hemostasis

A hemostasis procedure is sometimes required to control the bleeding that results from removing polyps and other lesions. There are several ways to stop bleeding using an endoscope. In the clip hemostasis method, a small metal clip is attached to the blood vessel or injured mucosa. The clip acts to pinch the open blood vessel closed, and applies pressure to the tissue to stop the bleeding. In the localized injection method, a chemical such as ethanol is injected directly into the affected area, causing the blood to clot. Hemostatic forceps that use high-frequency, meanwhile, can securely grip large blood vessels or hard and slippery tissue, enabling coagulation to occur before resection.

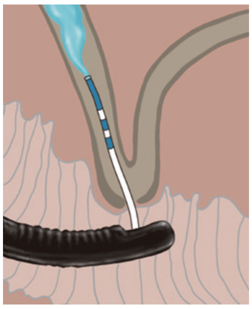


Clip hemostasis

High-frequency hemostatic forceps

ERCP (Endoscopic Retrograde Cholangio Pancreatography)

ERCP is method for examining the biliary duct and pancreatic duct using a combination of endoscopic and radiographic techniques. Using an endoscope, a thin tube (cannula) is inserted through the papilla of Vater into a duct of the pancreaticobiliary system. Radiological contrast dye is then injected into the ducts, and the area is viewed using x-rays. ERCP allows the doctor to check for the presence of pancreatic cancer, biliary duct cancer, gallstones etc.

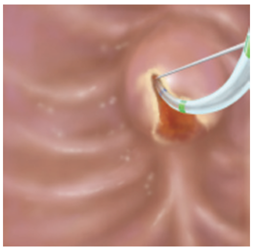


ERCP

Imaging tube

Endoscopic Sphincterotomy

Endoscopic Sphincterotomy is a procedure that is often used to remove gallstones or to treat strictures of the papillary muscle. A papillotomy knife (papillotome) is inserted into the opening of the duodenal papilla, and the papillary sphincter is cut open. Following this, a balloon catheter or basket catheter can be inserted into the biliary ducts to remove any gallstones residing in the biliary system.

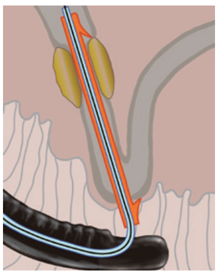


Endoscopic Sphincterotomy

Papillitomy knife

EBD (Endoscopic Biliary Drainage)

If the free flow of bile to the duodenum is hindered due to gallstones or a stricture (narrowing) of the bile duct due to disease, ERBD may be performed by inserting a polyethylene or metal stent into the duct to allow the free flow of bile.



EBD

Polyethylene biliary stent

Metal stent

Surgical Products

Special Interview: Potential of Endoscopic Surgery

Honorary Director, National Hospital Organization Tokyo Medical Center
Member of the New Strategy Promotion Special Investigating Committee, Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society
Auditor, Japan Society for Endoscopic Surgery

Sumio Matsumoto

1973: Graduated from Keio University School of Medicine
1973: Trainee Surgeon, Keio University School of Medicine
1980: Surgeon, National Hospital Organization Kanagawa Hospital
1982: Assistant Professor in Surgery, Nagoya Health University School of Medicine
1984: Assistant Professor in Surgery, Fujita Health University College School of Medicine
1990: Associate Professor of Surgery, Fujita Health University School of Medicine
1993: Professor of Surgery, Fujita Health University School of Medicine
2000: Director, Banbuntane Hotokukai Hospital, No. 2 Teaching Hospital, Fujita Health University
2005: Director, National Hospital Organization Tokyo Medical Center
2014: Honorary Director, National Hospital Organization Tokyo Medical Center

Notable involvement in academic associations, etc.
Member of the New Strategy Promotion Special Investigating Committee, Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society; Auditor, Japan Society for Endoscopic Surgery; former Executive Director, Japan Hospital Association; chairman of the ethics committee, member of the social insurance medical care fee committee, and member of Gaihoren at the Japan Hospital Association; chairman of the 25th Conference of the Japan Society for Endoscopic Surgery; chairman of the 62nd Conference of National Hospitals; Administrator, 28th Conference of the Japanese Research Society of Surgical Cancer Immunology; Advisor, Japan Laparoscopic Hernia Surgery Society, and other positions

Endoscopic surgery has made dramatic advances in recent years, with operations such as gallbladder removal having become standard procedures. We spoke to Sumio Matsumoto, Honorary Director of the Tokyo Medical Center, about the potential for further advances in this field.

Q: What has endoscopic surgery brought to the field of surgical treatments?

A: The biggest difference from open surgery is that endoscopic surgery is a minimally invasive therapy. By enabling patients to return quickly to their daily lives, this has reduced losses on both an economic and a social level. When I first became a surgeon about 40 years ago, the attitude of open surgery was “the greater the wound, the greater the surgeon,” with patients unable to get up for a week due to pain from the wound. In contrast, in the case of a simple benign procedure, patients who have undergone modern endoscopic surgery can be up and about ready to return home the following day.

The widespread adoption of endoscopic surgery began after it built up a reputation for success in surgery for cholelithiasis (gallstone disease), a non-malignant condition. I had my eyes opened to the technique at a video session on gallbladder removal during an international conference on gastrointestinal surgery in Toronto in 1989, and only a year later in 1990 I performed my first local excision of an early gastric carcinoma.

In 1991, I performed the first inguinal hernia operation in Japan. In those days, many surgeons were unfamiliar with laparoscopic surgery, with many preferring to use the mesh plug insertion procedure which has a simpler frontal approach, and therefore interest temporarily died down in the laparoscopic repair of inguinal hernias, a surgical technique that is difficult to learn. Nevertheless, the simpler technique doesn’t sufficiently reinforce the area where the hernia occurred, resulting in relapses and other negative outcomes. This led to a recognition of the benefits of using laparoscopic surgery, which enables the surgeon to directly observe what is happening as they work and thereby to properly reinforce the site of the hernia and prevent a relapse, and I have been aware of a rising number of surgeons wanting to learn the technique since around 2012. A survey by the Japan Society for Endoscopic Surgery showed a rise in the relapse rate over the past few years. I suspect this may be the result of procedures not being performed appropriately because of the large number of surgeons adopting the technique for the first time. I would like to take advantage of mechanisms such as skill qualification examinations to promulgate appropriate practices.

In the case of operations on malignant tissue, laparoscopic excision of colon cancers was first reported in 1993, with operations such as gastrectomies and esophagectomies (respectively, removal of part of the stomach or esophagus) now in the process of becoming standard procedures in recognition of the reduced stress they impose on the patient. In fact, laparoscopic surgery has become widely used for cancer surgery at high-volume centers (clinics that operate on a large number of cases) that perform a variety of difficult surgical procedures.

Q: How will minimally invasive therapy become more widely adopted in the future?

A: When you look at the current situation, where laparoscopic surgery is desirable for both surgeons and patients, I believe it will spread into new fields, such as cancer of the larynx and pharynx in ear, nose, and throat (ENT); cancer of the uterus in gynecology; and cardiac bypass surgery.
However, endoscopic surgery is a difficult technique to learn and having it more widely adopted as a safer surgical procedure requires robust mechanisms to be put in place through the skills certification program that commenced in 2005 by the Japan Society for Endoscopic Surgery. The skills certification program allocates 60 points to generic skills such as the use of forceps and electrosurgical knives during general endoscopic surgery, and 40 points to the various organs, with the two independent examiners needing to award a total of 70 points or more to achieve a pass. However, certification does more than just qualify the surgeon to use the technique, rather it is intended to assess whether they have reached the level needed to be a supervising surgeon. The pass rate of 30% to 40% means that certification is very difficult to obtain by the standards of such industry qualifications.

Q: Will use of endoscopic surgery also spread to emerging nations?

A: Surgeons from emerging nations who have acquired skills through study in nations with well-developed medical practices are using endoscopic surgery in their home countries. There is a training facility for endoscopic surgery in Taiwan that is headed by a French surgeon, and I have visited there to teach about inguinal hernia repair operations. I noted that they even had people coming to train there from Australia.
I understand that Olympus has opened training facilities in Thailand and China at Beijing, Shanghai, and Guangzhou. I have been aware of young surgeons from places such as South America and Central Asia coming to train in Japan over the last 30 years, and with endoscopic surgery likely to become routine in these countries as they become more developed, I believe that training institutions like these that include endoscopic surgery as well as gastrointestinal endoscopy will be needed all over the world in the future.

Q: How do you see the technology of surgical endoscopy developing in the future?

A: Olympus 3D endoscope looks like an extremely promising instrument. For example, delicate tasks such as suturing are difficult for beginners to perform using a 2D image because it is so hard to get good depth perception, and it has been demonstrated that 3D images that provide a sense of depth make a significant difference by shortening the time taken for such tasks.
Robotic assisted surgery, meanwhile, not only reduces the physical workload of the surgeon, it is also said to shorten the time taken for surgical training compared to laparoscopic surgery. Prostatectomies using the American-made Da Vinci system received insurance cover approval in 2012, and at the Tokyo Medical Center we have already performed robotically assisted gastrectomies several times. Since this uses two cockpits, with two surgeons working alternately to perform the operation, it enables a new relationship unlike the surgeon and assistant relationship used for open surgery.
In the future, I would like to see Olympus developing the sort of products that only you could produce. In terms of what surgeons like myself are looking for, numerous research institutions are working on developments such as robot arms that can perform automatic suturing or ligation, or forceps that provide tactile feedback, and I look forward to these being commercialized.
I am also a member of the Cabinet Office's IT Promotion Strategy Committee, and speaking in that capacity there is a need for the development of instruments and services that

incorporate advances in IT. For example, capsule endoscopy is used to perform examinations by having a receiver collect data from a capsule inside the patient's body. Shouldn't it also be possible to have a service that sends this data via a network to a facility with diagnostic capabilities, and then receives a prompt result? Because this only requires the patient to swallow the capsule, it would enable examinations to be carried out even in places that lack medical infrastructure, such as clinics that do not have an endoscopy specialist.

Furthermore, work is also progressing on systems that get patients to fill out a questionnaire on a PC or tablet computer while they wait at an outpatient clinic, thereby making their electronic medical records immediately available. This enables doctors to quickly identify the suspected ailment when they carry out a diagnosis, and deal promptly with things like getting tests done. Such systems are close to being realized and should be ready by the time of the Tokyo Olympics.

Using IT in this way to improve services is also vital when you consider the trend toward an aging population and lower birth rate, and I believe Olympus needs to produce systems that are compatible with such an environment.

Q: What benefits have collaboration between medicine and industry brought to surgical treatments, and what do you see as the future possibilities and challenges?

A: I believe in the importance of collaboration between medicine and industry. At the Japan Society for Endoscopic Surgery with which I was involved in 2012, we set up the first plaza for medicine-industry collaboration in the form of an exhibition space where surgeons, researchers, and companies exchanged views face to face. Currently, there are numerous initiatives underway for strengthening collaboration between medicine and industry, including the "Monozukuri Commons" which provides a forum where companies and physicians can meet at different places. The Japan Society for Endoscopic Surgery is also working on a variety of projects.

As I believe there would be no advances in endoscopic surgery were it not for collaboration between medicine and industry, increasing the number of such forums in the future is significant for all parts of the medical equipment industry.

I have myself been involved in the development of a variety of products since being approached by an Olympus engineer when attending a conference in the early 1990s. While some of these developments never reached the market, I believe that getting doctors and vendor company engineers facing in the same direction and engaging in debate is vitally important for the progress of medical technology. A good example of this, I believe, are the THUNDERBEAT energy devices, world-first products that combine bipolar high-frequency current with ultrasound.

In this way, I am aware that Olympus is striving to identify diverse market needs through discussion with doctors like myself. I look forward to you continuing to develop products that satisfy market needs.

Q: Finally, please tell us your views if there is anything you would like from Olympus in the future?

A: While Olympus medical instruments such as gastrointestinal endoscopes and laparoscopes tend to be completely adequate in a technical sense, I believe there is room for further enhancements by incorporating technologies from outside medicine. The use of wireless technologies such as Bluetooth to eliminate the need for cables in endoscopes, for example, would make them more maneuverable and convenient to use. Similarly, progress on shifting to the cloud servers used for filing endoscope images at each institution would enhance convenience and reduce costs at hospitals.

As a Japanese manufacturer of medical instruments, Olympus is recognized as one of the few companies with the technology to take on the world. In the future, I look forward to you also utilizing the latest technologies from outside the company to further improve your products and services.

Engineer's Interview: This is How we Make Progress on Minimally Invasive Therapy

Manager, Energy 1 Group, Therapeutic Products Department,
Medical Product Development Division 2, Olympus Corporation.

Eiji Murakami

One of the two valuable methodologies delivered by the Olympus medical business, minimally invasive therapy reduces the stress on the patient and enhances their subsequent quality of life (QOL). The company's THUNDERBEAT electrosurgical devices used in operating rooms were also developed with this objective in mind. In this article, Eiji Murakami, who has had a long involvement in the development of endotherapy devices and surgical products, including responsibility for the THUNDERBEAT development, tells us about the nature of the minimally invasive therapy provided by Olympus.

Even Shorter Hospital Stays

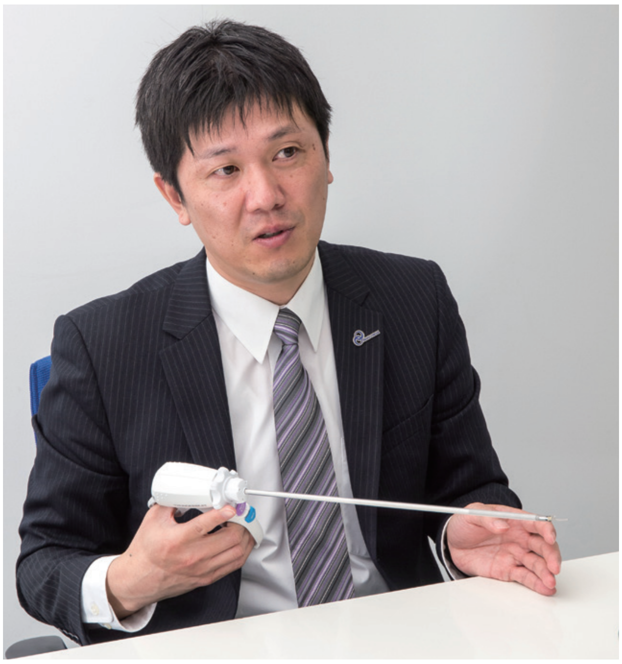
Q: To begin, what is meant by minimally invasive therapy?
A: While definitions vary, the term is generally used for procedures that are less invasive than conventional surgical techniques. The simplest definition is that the extent of scarring to the body is smaller. Also that this results in the patient being more quickly rehabilitated back to society. Yet another definition is to complete a procedure more quickly to reduce the stress on the patient. Also, to be able to receive hospital treatment at lower medical cost. I think all of these things together make a minimally invasive therapy.
Q: Endoscopic surgery is a typical example of a minimally invasive therapy. In what ways is it less invasive than conventional surgical techniques?
A: Conventional techniques often involved subjecting the patient to highly invasive procedures such as making a large incision in the abdomen, or the severing of rib bones in the case of chest operations. For various conditions, the widespread adoption of endoscopic surgery has seen these replaced by minimally invasive therapy and I believe this has lowered the barriers to people undergoing surgery. It has shortened the month-long hospital stays associated with laparotomies, for example. Depending on the nature of the case, it has become a matter of course for patients to be back to their normal lives one week after their operation.

Technology Advances in Collaboration with Doctors

Q: How has the field of endoscopic surgery made considerable progress since the early days?
A: Operating times have shortened and the stress on patients has been reduced. Gastric resections, for example, typically used to take five or six hours, whereas now they are often completed in three to four hours. While this is in a large part thanks to advances in doctors' skills, I believe that the improvements to medical equipments have also played a part.
Q: In other words, you made advances in tandem with doctors?
A: That's right. When developing medical equipment, it is only by working closely with doctors that we can deliver high quality and minimally invasive surgery to their patients. Unless the end result is more effective in a medical sense, such as being less invasive, there is no point in simply seeking to improve device performance and developing products that are designed specifically for cutting or holding and nothing else. There are aspects that only a doctor can judge, therefore, it is essential that we work in collaboration with doctors to verify product benefits.

Strength of Doctors' Concern for Patients

Q: Does minimally invasive therapy have advantages for doctors?
A: While it may be less invasive for the patient, essentially endoscopic surgery makes life more difficult for doctors. For example, the way doctors must keep in mind risks such as hemorrhaging while viewing a video monitor with a limited field of view means the work is more stressful than open procedures like laparotomy. Choosing a minimally invasive therapy should not lead to any drop in the effectiveness or quality of surgery. Numerous measures have to be taken to find ways of



maintaining the effectiveness of treatment at the same level as conventional methods. For example, operations for stomach or colon cancer resection require lymph node dissection, a measure to prevent recurrence. We need to ensure that a doctor can perform this procedure through endoscopic procedures with the same accuracy as in an open laparotomy that gives a direct view and allows doctors to feel with their hands. Our job is to assist in making this a reality.

Q: Given the pressured and stressful environment you have described, what is it that motivates doctors to give these techniques a try?

A: I believe it comes down to concern for their patients' quality of life. They are motivated by a genuine desire to find ways of providing treatments that place less stress on the patient. A common comment from the doctors that we receive during product development is that even a 1% reduction in the rate of cancer recurrence is worth pursuing, and this point cannot be compromised, even in the case of minimally invasive surgery. For ourselves, we appreciate that we need to develop devices that satisfy this requirement.

Meeting Doctors' Need to Act for Patients' Benefit

Q: What do you believe is the best way to respond to this enthusiasm among doctors?

A: Unlike gastrointestinal endoscopes, Olympus got into the surgical business, particularly therapeutic devices, at a later period. We started as a market follower and have developed our products by adding minor enhancements to differentiate them from what was already available on the market. However, we came to realize that this would not deliver the level of surgical quality that doctors were seeking. An important factor in the creation of superior products, I believe, is that we pursue what is needed to genuinely satisfy doctors' needs. While one point of emphasis in our development is to provide doctors with ideal treatments they can use without stress, we also need to meet the doctors' objective of making these treatments less invasive for the patient. In other words, to provide treatments that are more effective in medical terms. In my view, we will be able to become a market leader when we become capable of offering such value.

Q: How do you deal with after-sales service, training, and other support for doctors?

A: To ensure that therapeutic devices are used safely, we need to provide users with precautions and instructions for use. Particularly in the case of entirely new products like THUNDERBEAT, this activity is even more important than in the past. Including for THUNDERBEAT, we are establishing mechanisms with which we work with marketing department to prepare materials that describe usage and precautions, and then our sales force in each market use them as the sales training tool. We hold regular meetings with marketing sections to exchange information, and provide follow-up on technical information when required.

THUNDERBEAT Combines a Hemostasis Function with Unprecedented Cutting Speed

Q: Can you describe the new products you developed in more detail? The THUNDERBEAT is a unique surgical energy device that our competitors don't have. What makes THUNDERBEAT special?

A: The most distinctive feature is the operating mode that simultaneously generates both ultrasonic energy for coagulation and cutting and bipolar high-frequency energy for hemostasis and sealing of blood vessels. Whereas separate specialized instruments were needed for these procedures in the past, we have now combined the functions into a single device. As a result, THUNDERBEAT offers an unprecedented cutting speed and reliable hemostasis function. By enhancing the performance of basic procedures such as grasping or dissecting tissue, we have been able to develop a single instrument that can be used for a wide range of purposes. We anticipate that this will significantly reduce the number of times instruments are switched during surgery, consequently shortening operating time and relieving stress on the doctor.

Q: In realizing this product concept, what difficulty did you face during development?

A: The hemostasis function is strongly influenced by the device specifications. We put a lot of design effort into the question of how to satisfy the conflicting requirements of effectively sealing blood vessels while at the same time achieving fast cutting. It is not something that can be achieved simply by combining the two forms of energy, We spent a long time to study various tip shapes and energy output conditions before we successfully realized the product concept.

Q: How does the performance of THUNDERBEAT contribute to providing minimally invasive therapy?

A: I expect that reliable hemostasis helps prevent complications such as bleeding during or after the operation. Also, by realizing improved surgical efficiency, such as procedures being performed more quickly and less switching of instruments, operating time gets shorter and the stress on the patient as well as on the doctor is reduced. Once doctors become accustomed to the faster surgery made possible by THUNDERBEAT, they would not be satisfied with surgery performed with conventional instruments.

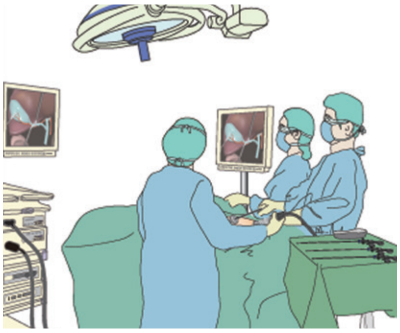
Numerous Developments Targeted by Minimally Invasive Therapy

Q: Please tell us about the future direction of device development for advancing the field of minimally invasive therapy?

A: Just as we have applied technologies developed for the endotherapy devices used with gastrointestinal endoscopes to endoscopic surgery devices, for example, we believe we can also apply technologies from endoscopic surgery in open laparotomy. Since endoscopic surgery is complex and difficult, progress is being made on technologies to make devices easier and faster to use. If these devices can also be used in laparotomy, I believe they can help make the procedure less invasive by shortening operating time.

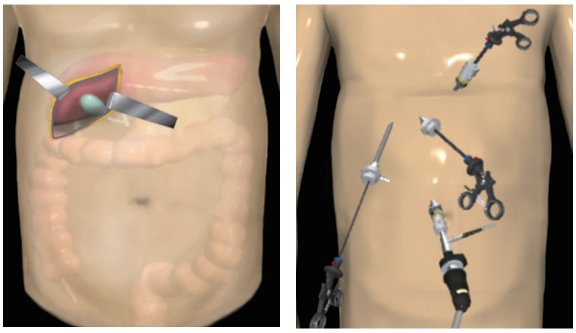
Naturally, we are also looking to develop new devices that will allow endoscopic surgery to be used for cases that, currently, can only be operated on by laparotomy. For example, as endoscopic surgery is still only used for about 30% of stomach cancer operations, we are developing devices that will allow half of the remaining 70% to be done endoscopically, and also devices that will allow the other half that continue to be performed by laparotomy to be done with minimally invasive techniques. Another line of device development is aimed at making procedures already performed under endoscopy even less invasive. As these examples demonstrate, we continue to work on a wide range of technical developments.

The History of Endoscopic Surgery



Endoscopic surgery

Comparison of gallbladder removal surgeries



Laparotomy　　Endoscopic surgery

Development of Surgical Techniques

Surgery is only one means of treating an injury or curing a disease. In ancient times, the primary treatment for medical problems was "internal medicine," where people were treated with drugs without having surgery. Using a scalpel only brought danger and pain. However, since the 19th century, anesthesia, blood transfusions, and disinfection practices have been developed, and technology such as antibiotics has evolved to protect the condition of the patient during and after surgery. Surgery has since become a main discipline on par with internal medicine.

Nevertheless, surgery is still encumbered by the problem of its tremendous "assault" on the human body. The medical term is for this is "invasiveness." With most surgeries the patient not only has to recover from the intended procedure (such as removal of the gallbladder) but also from the accompanying procedure (such as making a large incision in the abdomen in order to gain access to the gallbladder). Often the incisions required to obtain access to the organ to be operated are the main reasons for the patient's lengthy recovery.

Endoscopy Brings a "Revolution"

What brought about a recent "revolution" in surgery was the development of "endoscopic surgery," a kind of surgical treatment that makes use of an endoscope for access.

As opposed to existing laparotomy and thoracotomy procedures, endoscopic surgery is a new kind of surgery that requires only a few small holes to be made in the skin of the abdomen or chest. It is performed using long-shafted forceps, electric scalpels and other hand instruments while viewing the inside of the body through a laparoscope or a thoracoscope (endoscopes for viewing the abdomen and chest). The reason why endoscopic surgery is so revolutionary is because it greatly lowers the invasiveness of surgical treatment, while at the same time greatly increases the patient's quality of life (QOL).

The history of endoscopic surgery goes back to 1910, when thoracoscopes were used in the treatment of pulmonary tuberculosis. In the 1960's endoscopes were being used in the fields of urology and gynecology in Europe. They became a common way to treat urinary tract stones.

In 1978, the German surgeon Kurt Semm developed an automatic insufflator (a device that pumps carbon dioxide gas into the abdominal cavity in order to expand it and create a space for observation and surgery). This device greatly facilitated his performance of endoscopic gynecological surgery.

The Accomplishments of Mouret

In 1985, the German surgeon Erich Muhe performed an endoscopic gallbladder removal.

However, the man who was instrumental in the spread of endoscopic surgery on the gallbladder was the French surgeon Philippe Mouret. In 1987, he performed a gallbladder removal by attaching a CCD camera to the laparoscope and projecting the resulting video image on a TV monitor. He established the current style of laparoscopic surgery where the surgery is performed cooperatively under the shared vision of doctors, assistants, and engineers.

The first endoscopic gallbladder removal in Japan was performed in 1990 by Professor Tatsuro Yamakawa of Teikyo University. Starting in 1991, endoscopes were being used to resect the stomach for the treatment of stomach cancer.

Since the early 1990's there have been many technological advancements in addition to the accelerated clinical use of endoscopic surgery. As stated previously, a key development was the coupling of endoscopes to external CCD cameras. The ability to view the operation on a video monitor allowed for a high level of cooperation between doctors and their assistants. The development of devices and equipment for surgery in body cavities that cannot be reached directly by hand progressed rapidly.

Post-operative scars are small

Olympus Medical Training Center
(Hamburg, Germany)

Olympus Surgical Technologies America
(Massachusetts, U.S.)

Shortened Hospitalization

Endoscopic surgery has many advantages over open surgery. First, for the patient, post-operative scarring is typically much less compared to laparotomy. Smaller incisions usually lead to less time spent in the hospital and a faster return to work. Shortened hospitalization periods reduce the financial burden on private payers, insurance companies and government supported healthcare systems.

Obviously, for a doctor to perform a revolutionary new procedure he must learn a brand new set of skills. However, there are benefits to him as well, such as being able to magnify the target area and the ability to access organs that are deep in the body and that are therefore difficult to access via open surgery (e.g., kidneys). Compared with prior surgical methods where it was difficult for all to see what the surgeon's hands were actually doing, endoscopy makes it easier to train young doctors by using the video monitor to show the surgical process. The numerous benefits of endoscopic surgery, which outweigh its disadvantages, are driving its popularization.

Health Insurance Coverage Starts in 1992

In Japan, starting in 1992 with gallbladder removal, endoscopic surgery is rapidly becoming covered by health insurance. Hernioplasty, lung resection, and gynecological surgeries were covered by health insurance starting in 1994, stomach resection in 1995, and 18 surgeries including splenectomy and liver removal in 1996.

Categorized by the parts of the body, 49 techniques for the gastrointestinal system, 14 for the respiratory system, 25 for gynecology, 46 for urology, and 14 for ear, nose, and throat have been approved for use under Japanese health insurance. Work is also in progress on applications to other parts of the body.

Activities aimed at spreading endoscopic surgery are also popular in Japan. The Society for Endoscopic Surgery was started in 1990, and the Japan Society for Endoscopic Surgery (JSES) was established in 1995. The goals of these societies include both research and education. As of July 2008, membership was around 10,000. These societies foster increased awareness of endoscopic surgery through various conferences and publications, and certify technical competence in these new procedures through their physician certification programs.

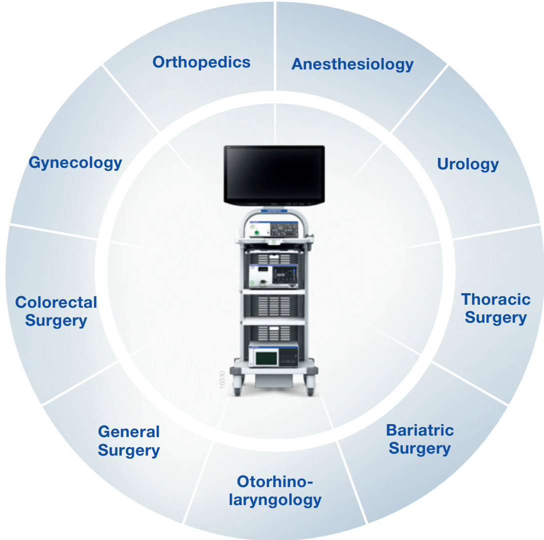
Olympus and Surgery

Olympus had already by the end of the 1960's anticipated the use of endoscopes in surgery. In 1979 we increased our capabilities in this field by acquiring the German rigid endoscope manufacturer Winter & Ibe. Since then, Olympus has introduced innovative products, including surgical endoscopes with high-definition imaging and the world's first surgical energy device that can simultaneously generate both high-frequency electric current and ultrasonic vibrations.

Endoscopic Surgery Systems and Devices

A Broad Product Line is Key

Equipment used in endoscopic surgery can be roughly divided into 3 groups: 1. Endoscopes, 2. Video processors and light sources, 3. Instruments such as electrosurgical knives. As open surgery is gradually being replaced by endoscopic surgery, the sophistication of endosurgical equipment has increased.



Endoscope

There was a time when all surgical endoscopes were metal tubes containing multiple lenses. However, these are being replaced by videoscopes that employ CCD image sensors in their tips, due to the increased sharpness of their image and their improved ease of maintenance.

In general, videoscopes have a diameter of 5mm and a length of 320-370mm. Their tips contain a lens, a CCD image sensor, and light guide fiber bundles for bringing illumination into the body. Some models are straight, others have deflectable tips. The CCDs in Olympus endoscopes support high definition imaging. Focusing is unnecessary due to their broad depth of field.


Surgical scope

Rigid Endoscope

A wide variety of telescopes are used for various types of diagnosis and treatment, especially general surgery. Uses in urology include transurethral prostatectomy and nephrectomy (kidney removal). Uses in ear, nose, and throat include viewing the eardrum, nasal cavity, and vocal cords, which is performed using a thin rigid endoscope. Rigid endoscope are also used for myomectomy in gynecology and for viewing inside joint cavities in orthopedics.


Telescope


Ear and nose / Otoscope


Urology / Resectoscope


Arthroscope

Video System Center

The unit both serves as a processor that converts the electrical signals from the videoscope into video signals to display on an LCD monitor and functions as a light source that supplies light to the scope tip via the light guide cable. Olympus products are notable for their image enhancement achieved by using opto digital techniques such as Narrow Band Imaging (NBI). A feature of the models sold in Europe and U.S. is that they can work with both rigid and flexible scopes.

Video System Center

Insufflator

A necessary part of endoscopic surgery is requirement for an insufflator. The insufflator feeds carbon dioxide gas into the abdominal cavity in order to expand it and create a working space to perform surgery. A special insufflation needle (Veress needle) delivers the carbon dioxide gas to the peritoneal cavity. The insufflator monitors the pressure of the peritoneal cavity and automatically pumps in additional gas as needed to make up for gas that naturally leaks out during surgery.

Insufflator

Trocar

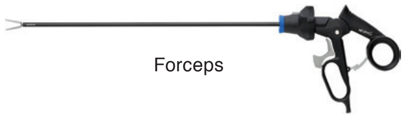
Trocars are used to create an opening (portal) for passing endoscopic instrumentation into the body. The endoscope, forceps, electrosurgical knives, hemostatic/suturing equipment, etc., are then inserted through the trocar as needed for surgery. Olympus offers various types of trocars available in diameters ranging from 5-15mm. Currently, the most common trocars come with a sheath and are single-use

5mm 11mm 12mm 15mm

Trocars

Forceps

There are various kinds of forceps – such as grasping forceps that hold tissue and needles, dissecting forceps that mechanically separates tissue, scissor forceps for cutting tissue, etc.



Forceps

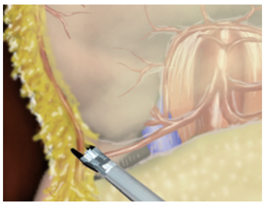
Tip of grasping forceps

Tip of dissecting forceps

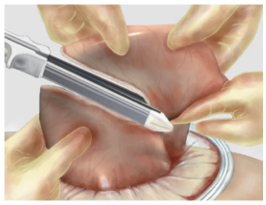
Hemostasis Clip, Surgical Stapler

In endoscopic surgery, clips are often used to quickly close a blood vessel and stop bleeding that cannot be controlled by other means. The clips are held in a pistol-shaped clip applier. Clips are applied repeatedly like a stapler.

A surgical stapler is a device that can create two rows of staples (3-6 cm in length) and then cut the tissue between these rows, all in one motion. In the tip of the instrument is a cartridge containing the staples and an automatic knife blade. When the handle is squeezed, the staples are fired and the tissue is cut and separated, all at the same time.



Hemostatic clip (image)



Endoscopic stapler (image)

Ultrasonic Energy Device

Ultrasonic devices for coagulation and cutting by converting electricity into ultrasonic vibrations. The heat is generated when the tip of the device (scissors) contacts the tissue and then cuts the tissue and causes coagulation (hemostasis).

Ultrasonic Energy Device

High-Frequency Electrosurgical Device (Electrode)

Olympus has commercialized electrosurgical knives that use high-frequency current as an energy source. These devices come in two types, monopolar with one electrode and bipolar with two electrodes. Bipolar knives in particular are capable of ablation for small lesions, for example. This minimizes the risk of thermal damage to surrounding tissue.

High-Frequency Electrosurgical Device (Electrode)

New range of THUNDERBEAT models, the world's first and fully-integrated bipolar/ultrasonic energy devices

THUNDERBEAT Open Fine Jaw for open surgical procedures

Designed to be smaller and lighter than previous models, the fine tip shape and ergonomic grip of the new model enable more exacting surgery to be performed. Open Fine Jaw is used in all areas of general surgery, including gastrointestinal area.

THUNDERBEAT Open Fine Jaw

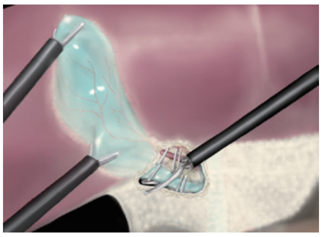
Output Unit

Examples of Endoscopic Surgery

Ever since Dr. Mouret of France performed a gallbladder removal endoscopically in 1987, endoscopic surgery has spread to a number of fields. Research and application of endoscopic surgery is currently progressing in the digestive tract, the respiratory system, the urinary system, the field of otorhinology and gynecology, etc. This chapter will introduce some representative examples of this kind of surgery.

Laparoscopic Cholecystectomy

This is the most common type of endoscopic surgery in Japan, with approximately 26,000 cases being performed each year. It is typically performed for benign gallbladder problems, such as gallstones, polyps in the gallbladder, adenomyomatosis of the gallbladder, etc.
The gallbladder is attached to the underside of the liver, and must be carefully removed using an electrosurgical knife and dissecting forceps. Next, the cystic artery and cystic duct are clamped with clips and cut to separate them from the liver. Finally, a trocar is inserted and the gallbladder removed from the body through the trocar using grasping forceps.

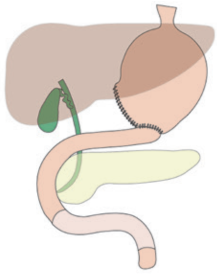


Detachment of gallbladder

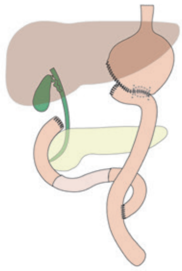
Removal through incision

Laparoscopy- Assisted Distal Gastrectomy (LADG)

This surgery is limited in application to early-stage cancers from the lower part of the stomach (pyloric antrum) to the middle of the stomach (body of the stomach). The standard procedure is to remove at least two-thirds of the stomach and the lymph nodes around the stomach. The reason this is called a "laparoscopy-assisted" procedure is that the surgery requires a laparotomy, albeit with a smaller incision.
The two basic methods for reconstructing the stomach are the Billroth I method and the Roux-en-Y method. In the Billroth I method, the remaining stomach and the duodenum are joined. In the Roux-en-Y method, the remaining stomach and the jejunum are joined, and the remaining duodenum is connected to the bottom of the jejunum. Food flows from the stomach to the jejunum, where it mixes with digestive fluids that flow in from the duodenum.
If these surgeries are not appropriate for the patient, there is still another kind of stomach cancer surgery called Laparoscopy-Assisted Total Gastrectomy (LATG).



Billroth I method



Roux-en-Y method

Laparoscopy-Assisted Colectomy

Colorectal cancer surgeries target the large intestine, cecum, and rectum. As with stomach cancer, the goal of these surgeries is to remove the affected area as well as the associated lymph nodes.
Compared to the stomach, the structure of arteries and veins supplying the colon is simple and the removal of associated lymph nodes is easy. Therefore, it is said that there is a high chance that laparoscopy-assisted colectomy may become the standard surgery for colorectal cancer in the near future.

Nissen fundoplication

Nissen fundoplication is a surgery for treating Gastroesophageal Reflux Disease (GERD). GERD is a disease characterized by heartburn, chest pain, bitter taste in the mouth, etc., caused by the reverse flow (reflux) of stomach fluids back up the esophagus. A laparoscope is used to surgically create a fold around the esophageal sphincter to prevent the reverse flow of stomach contents.

Pulmonary Resection

Lung cancers are now being surgically resected using endoscopes. Thoracoscopic partial lung resection surgery can be performed for removing tumors smaller than 3cm in diameter, and lung lobectomies performed for treating areas greater than 4cm in breadth.

Endoscopic Sinus Surgery (ESS)

A minimally invasive therapy for treating sinusitis (empyema) in which chronic inflammation of the paranasal sinuses (cavities enclosed in bone located near the nasal cavity) causes them to fill with pus and contaminated mucosas. Endoscopic sinus surgery uses an endoscope to provide a view inside the nose while using a debrider (a surgical instrument for removing abnormal tissue with simultaneous use of suction and cutting) to perform treatment.

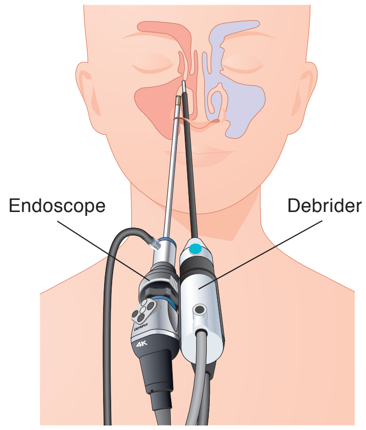


Image of Endoscopic Sinus Surgery

Transurethral Ureterolithotripsy (TUL)

A minimally invasive therapy for treating urinary stone, a condition in which substances contained in urine crystalize for some reason and coalesce in the form of a stone. It involves inserting a thin endoscope via the urethra and breaking up the stone in the urinary tract or kidney using a device for this purpose that works by laser. Once broken up, the stone is removed from the body using stone retrieval baskets.

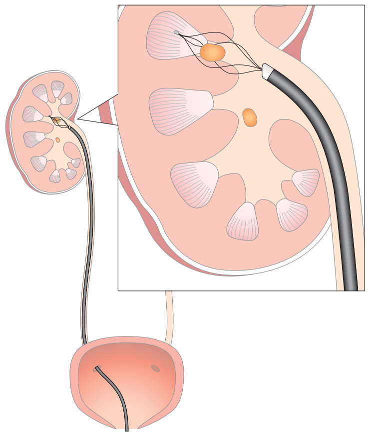
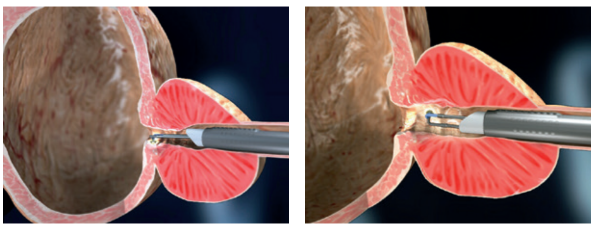


Image of removing stones with stone retrieval baskets

Prostate Resection or Ablation

Prostate resection is a minimally invasive therapy for the male affliction of Benign Prostate Hyperplasia (BPH) This procedure inserts a scope into the urethra and removes the enlarged prostate by scraping with a bipolar electrode or other instrument, or shrinks it by ablation.

Example of prostate ablation



A resectoscope is inserted transurethrally in the vicinity of the neck of the urinary bladder

Ablation of enlarged prostate

Others

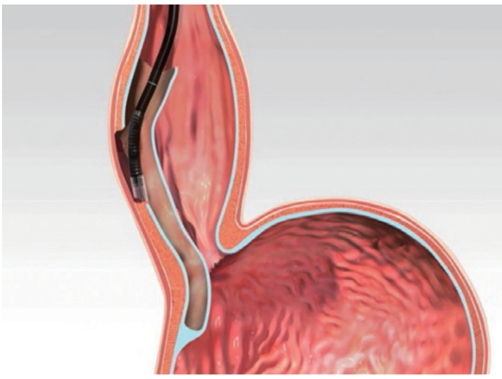
Procedures performed using endoscopes include nephrectomy (kidney removal) in urology, and endometriotic lesion removal, enucleatic myomectomy, and hysterectomy in gynecology.

Less Invasive Methods

POEM (Per-Oral Endoscopic Myotomy)

The development of less invasive surgical methods is progressing rapidly. One example is per-oral endoscopic myotomy (POEM), which is becoming recognized as a treatment for esophageal achalasia. Previous treatments were to take a calcium antagonist orally, balloon dilatation, or laparoscopic surgery in which part of the muscle layer from the esophagus to the stomach was removed. POEM is a new minimally invasive therapy that uses an endoscope to cut the muscle layer of the esophagus to improve the difficulty swallowing in the esophagus, and therefore does not leave any scar on the exterior of the body.

Note: Esophageal achalasia is a condition that results in problems such as obstruction in the passage of food or the stretching of the esophagus due to its peristaltic action (the action by which food is moved along the esophagus) being obstructed such that the sphincter at the bottom of the esophagus (esophageal muscle at entry to stomach) does not fully open.



POEM

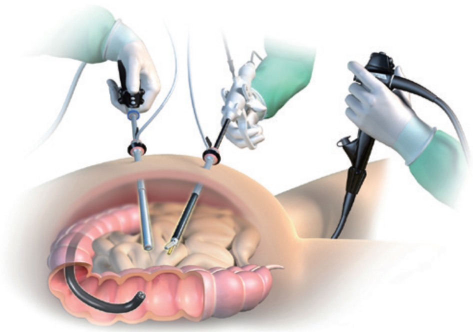
Other Initiatives

OR Integration

This means integrated surgical systems that have the effect of reducing stress on medical personnel and help endoscopic surgery proceed more smoothly through the use of centralized control to combine the operation of a number of instruments. With healthcare reform taking place around the world and a greater focus being placed on enhancing the efficiency of hospital management, OR integration provides a functional and efficient surgical environment.

GI in OR

This seeks to ensure that surgery is performed safely and efficiently by, for example, the use of a gastrointestinal endoscope during endoscopic surgery such as resection of the stomach or colon to visually check the surgical anastomosis, or to make follow-up observations after surgery. The endoscopic systems that Olympus supplies in Europe and U.S. have a major advantage over competing products because they are designed to also allow the connection of surgical endoscopes.



The History of the Olympus Medical Business

Year	Main Accomplishments
1950	Development of world's first practical gastrocamera
1952	Above mentioned gastrocamera commercialized, unveiled as GT-I
1955	Gastrocamera Research Group established
1964	GTF gastrocamera fiberscope released
	Established corporation in Europe
1966	GFB fiberscope for biopsy released
1968	Established corporation in U.S.
1974	Partnership with Winter & Ibe GmbH in Germany (entered into surgical endoscopy area the next year)
1979	Winter & Ibe GmbH becomes subsidiary
	Establishment of U.S. location in California (currently the world's largest endoscope service center)
1982	Endoscopic ultrasound system introduced
1985	EVIS-1 endoscopic video system announced
1987	KeyMed Ltd. (U.K.) becomes subsidiary
1989	Beijing residential office established
	Established corporation in Singapore
1990	EVIS-200 series endoscopic video information system announced
1993	Established corporation in Russia
2000	EVIS EXERA series endoscopic video system introduced in Europe and North America
2001	Comprehensive partnership with Terumo Corporation for medical equipment started
2002	VISERA series video system for endoscopic surgery introduced
	EVIS LUCERA – the world's first high-definition endoscopic video system – released in Japan, the U.K., and parts of Asia
	Established corporation in Brazil
2004	Established marketing/services company for medical equipment in China
	Celon AG (Germany) becomes subsidiary
2005	Small intestine capsule endoscopy system introduced in Europe (expanded afterward to North America, Japan, and other regions)
	Established center for repair of endoscopy products and management of loan units in Japanese market (Shirakawa, Fukushima Prefecture)
2006	EVIS EXERA II and EVIS LUCERA SPECTRUM endoscopic video systems that include NBI introduced
	VISERA PRO surgical video endoscopy system introduced
	Established service company in Vietnam (now also responsible for sales)
	Established repair center for endoscopic products in Chinese market
2008	Gyrus plc. (U.K.) becomes subsidiary
	New plant for the production of digital cameras and medical equipment established in Vietnam
	Training centers established in Germany and China (Shanghai)
2009	Established medical equipment marketing company in India
	Commenced operation at new factory in Czech Republic
	Commencement of operation of new Czech factory announced
2010	Spiration Inc. (U.S.) becomes subsidiary
	Training center established in China (Beijing)
	Joint development with Siemens AG (Germany) announced regarding a magnetically-guided capsule endoscope
2011	Acquisition of ownership of US company Spirus Medical, Inc. an endoscope insertion device manufacturer
	Introduction of Surgical Imaging Platform "VISERA ELITE"
	Olympus' NBI Technology Recognized by the Japan Institute of Invention and Innovation
2012	Introduction of EVIS EXERA III and EVIS LUCERA ELITE, series of next-generation platform systems for gastrointestinal endoscopy introduced.
	THUNDERBEAT series of world-first composite electrosurgical devices that combine bipolar high-frequency current and ultrasonic energy introduced
2013	Sony Olympus Medical Solutions Inc. established (joint venture with Sony Corporation)
	Launched 3D surgical videoscope system (launched simultaneously with a 3D videoscope featuring a world-first tip bending function)
	Training center established in China (Guangzhou)
2015	Introduction of "VISERA 4K UHD" surgical endoscopy system incorporating 4K technology
2016	Training center established in Thailand
	Established corporation in Dubai
2017	Introduction of "VISERA ELITE II" surgical endoscope system
	Image Stream Medical, Inc. (U.S.) becomes subsidiary

Blue items indicate the establishment of new locations and subsidiaries.

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The Olympus Medical Business

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