
Endoscopic Surgery

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This book is dedicated to our wives, Joan Wright, M.D., and Deanna White, and to our families. In addition, we would like to express our gratitude for the ongoing encouragement and support of David State, M.D., to the development of our academic careers. We also dedicate this book to him.

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PREFACE

Endoscopic surgical principles and techniques are established methods of therapy in medical subspecialties, including gynecology, urology, and gastroenterology. Technologic advances in imaging and miniaturization of ablation, dissection, and coagulation devices have stimulated rapid adaptation of the methods to other disciplines, such as laparoscopic general or endovascular surgery. Continuing evolution of the technology, in particular, miniaturization of devices, is enabling catheter-based interrogation and therapy of small tubular structures such as the lacrimal or salivary ducts, and in confined spaces with difficult access, such as intracranial and spinal cord locations.

This book reviews in detail the development and principles of endoscopic surgery, emphasizing the intra-abdominal general surgical and endoscopic applications. Currently developing procedures and future perspectives are highlighted. The focus of the initial chapters is to review extensively the information regarding instrumentation, essentials of device fabrication such as fiberoptic transmission and imaging, pertinent safety considerations, and recommended credentialing guidelines.

The book emphasizes the multispecialty interest and perspective for use and development of the techniques, and provides an interesting comparison of the benefits derived from various approaches. An additional focus of the text is to identify developing procedures and technologies and to demonstrate the potential directions in the field.

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Introduction

Chapter 1

Evolution of Endoscopic Surgery

John E. Gunning, M.D.

Bruce A. Rosenzweig, M.D.

The evolution of operative endoscopy would be incomplete without due credit to the development of endoscopes, which make it all possible. Man's innate curiosity to view the inside of body cavities or canals dates back to the time of Hippocrates II (460–375 B.C.)¹ who mentions examination of the rectum by looking with a rectal speculum to see where the rectum is affected. The Babylonian Talmud refers to an instrument described in the thesis *Niddah* (65 B.C.) that is intended to distinguish between vaginal and uterine bleeding. This probably represents the oldest form of vaginal speculum and therefore the earliest incidence of endoscopy in gynecologic annals.¹ Archigenes of Apamea in Syria (95–117 A.D.) and Soranus of Ephesus (98–108 A.D.) both mentioned in their writings vaginal speculums.¹ Abulkasim (1012–1013 A.D.), an Arab, used a glass mirror to reflect light into the vaginal cavity.¹ He was thus the first to use reflected light for the purposes of illuminating and observation of the interior of a body orifice. The first endoscopic light should be credited to Tulio Cesare Aranzi who in 1585 wrote of using solar rays entering through a hole in a window shutter and brought to a focus through a spherical glass flask filled with water and projected into the nasal cavity.¹

Bozzani (1805 A.D.) of Frankfurt was the first to visualize the interior of the urethra, which he visualized in a human by using candlelight and a cumbersome tube as an endoscope.² Segalas (1826) of France refined the technique of urethroscopy by adding a cannula to the endoscopic tube as an obturator to facilitate introduction and a system of mirrors to reflect light into the cavity.² At about the same time Fisher of Boston described an instrument to inspect the vagina and extended its use to view the urethra.² Desormeaux (1835) is credited with being the father of cystoscopy when he developed the first servicable urethroscope and cystoscope by using mirrors to reflect light of a kerosene lamp.² In July 1869, Commander Pantaleoni of England described the use of a sponge tent by the Sims' method to dilate the cervix. Twenty-four hours later he introduced his modification of the Desormeaux endoscope into the cavity of the uterus and cauterized a hemorrhagic necrotic growth with nitrate of silver.³ His is the first description of endoscopic visualization of the endometrial cavity and use of the endoscopic tube as a channel to treat an abnormality and thus the birth of hysteroscopy in 1869.

Nitze (1877) added a lens system to the endoscopic tube that magnified the area being illuminated, and this lens system is the forerunner of the optical system of modern cystoscopy and all other endoscopes.² Edison (1880) invented the incandescent lamp, and Newman (1883) describes an instrument using the incandescent lamp as a light source.² Dittel, in 1887, placed a small incandescent lamp bulb at the tip of the break of the cystoscope.² Boisseau de Rocher (1889) separated the ocular part of the cystoscope from the sheath, thus allowing the use of multiple telescopes providing greater latitude of observation and making manipulation through the sheath possible.² It was also in 1889 that Poirer, using Boisseau de Rocher's instrument, successfully catheterized both ureters in a living subject.²

At the close of the 19th century cystoscopy and other open-cavity endoscopic procedures such as proctoscopy, laryngoscopy, and esophagoscopy were well established and in daily use in most medical centers. Ott, a famous Petrograd gynecologist, was the first to introduce endoscopic inspection of the abdominal cavity. In this "ventroscopy" procedure he inspected the abdominal cavity with the help of a head mirror and a speculum introduced through a small anterior abdominal wall incision. He published articles on the clinical use of this technique in 1901, 1902, and 1903.⁴ A few months later in the same year at the 73rd Congress of German Naturalists and Physicians, Kelling, a surgeon from Dresden, demonstrated its use on a living dog into whose abdomen he had inserted a cystoscope for the purpose of examining the abdominal viscera.⁴ He called the procedure "coelioscopy," which he described in his paper published in January 1902.

In 1910 Jacobaeus of Stockholm published two cases of visceral exploration: one abdominal and one thoracic. He used a cystoscope and trocar, as had Kelling, and called his method "thoraco-laparoscopy."⁵ His method was less advanced than that reported by Kelling in that Kelling had used a separate needle to produce a pneumoperitoneum with filtered air. Jacobaeus used no separate pneumoperitoneum needle but introduced air by means of the trocar used for the introduction of the cystoscope. On the other hand, he made a forward step by using his method in human beings and stressed its harmlessness when applied to patients suffering from ascites.⁴ In the meantime Kelling had perfected the technical aspects of the pneumoperitoneum procedure. He failed to publish his work or to transfer its use to humans. However, he deserves the credit of introducing closed-cavity endoscopy.⁶ In 1911 Bernheim, an assistant surgeon at Johns Hopkins, published in the *Annals of Surgery* an article entitled "Organoscopy."⁷ He described two cases where a proctoscope was passed through a small abdominal incision by using reflected light. By 1912 Jacobaeus had reported on 115 examinations in 69 patients, 42 abdominal and 27 thoracic.⁶ He described the liver changes in cirrhosis, metastatic cancer, lues, and tuberculous peritonitis and predicted a great future for laparoscopy.

Nordentoft and his brother of Copenhagen in 1912 designed an instrument that they called a "trocar-endoscope."⁶ In principle their method was identical to that of Kelling, Jacobaeus, and Bernheim. They are the first to report viewing the female pelvis in a cadaver that had been placed in the deep Trendelenburg position with an inflated abdominal cavity. The credit of using the Trendelenburg position belongs to them.

In 1912 at the monthly session of the Society of Internal Medicine and Pediatrics in Vienna, Tedesko told of his experiences with laparoscopy as practiced by Jacobaeus on patients with ascites.⁶ The discussion that followed indicated that the method had already been put to trial and had been retained by some of the clinicians in Vienna.

Meirelles of South America, in 1913, published a discussion on laparoscopy. This paper is

mentioned in most bibliographies on the subject matter; however, the original paper has been lost.⁶

In 1914 Roccavilla of Italy described a modified method of Kelling and Jacobaeus.⁵ He designed an instrument that permitted the source of light to remain outside the abdomen: a strong beam of light was directed by reflection into the trocar tube.

Orndoff of Chicago, in 1920, published extensive experiences using laparoscopic techniques in conjunction with roentgenographic screening.⁸ He denied knowing of the experiences of others and was the first to devise a sharp pyramid point, which he used on his trocar.

Zollikofer of Switzerland, in 1924, felt that laparoscopy offered its best diagnostic services in the afflictions of the liver.⁶ He introduced the use of carbon dioxide as the gas of choice for insufflation because it is easily and quickly absorbed. In 1924, Stone of Kansas, without knowledge of the work in Europe, used a nasopharyngoscope introduced in the abdominal cavity of dogs.⁹ He later learned that a similar method had been developed and used in Europe for some years. His technique described the fitting of the outer portion of the trocar with a rubber gasket that prevented the leakage of gas. Steiner of Atlanta, Georgia, published "Abdominoscopy" in 1924, a paper that refers to a new method of examination.¹⁰ He stated that he was unable to find any papers dealing with the subject, either experimental or theoretical. He felt he had discovered an entirely new diagnostic method that had never been tried before either on the living or a cadaver. His method varied little from that originally developed by Kelling.

Nadeau and Kampmeire of Chicago, in 1925, published a paper titled "Endoscopy of the Abdomen."⁶ This scholarly presentation is an extensive review of the literature representing the works of 22 investigators. In spite of numerous reports and frequent usage in the European countries the author states that "the method was seldom used."

Kalk, a brilliant German, was a most outstanding exponent and promotor of peritoneoscopy. He devised a new system of lenses that produced a foroblique (135 degrees) viewing system. He used a pneumoperitoneum needle. In 1929 Kalk reported his experiences with 100 laparoscopic examinations and described his own instrument and technique.⁴ His brilliant instrument led to the widespread adoption of the method in many countries. He can probably be referred to as the Father of Modern Laparoscopy, and it is to his credit that it became possible to study and to make an accurate pathologic diagnosis of internal organs. Probably the first operative procedure to be performed by utilizing endoscopic visualization and the first to utilize a second puncture should be credited to Kalk. An eloquent testimony for successfully performing directed liver puncture is the relevant passage in Kalk's book (Kalk and Wildhirt, 1962); 4,000 liver biopsy procedures are described without any serious complication. Kalk published 21 papers between 1929 and 1959, most dealing with liver and gallbladder disease.⁴

Operative procedures combined with endoscopy was reported in 1933 by Fervers, who burned abdominal adhesions and excised biopsy tissue under direct visualization.⁴ Ruddock, an American, perfected his own peritoneoscope, pneumoperitoneum needle, and trocar and described ancillary biopsy instruments. Ruddock's peritoneoscope was modified after the McCarthy cystoscope. He utilized air for the pneumoperitoneum and local anesthesia. In 1934 he published his work reporting an initial series of 200 cases.¹¹ Besides his original paper, Ruddock published his results in over 2,500 cases. Hope, a contemporary of Ruddock, suggested the use of peritoneoscopy in the differential diagnosis of ectopic pregnancy. He reported on ten cases, several of which were from the service of Ruddock.¹²

In 1937, Anderson of Texas reported using peritoneoscopy on a few cases.¹³ He states in his paper:

This work should be of special interest and value to the gynecologist as it allows ocular examination of intrapelvic reproductive organs and will help to decide the location and the variety of many masses found on bimanual palpation. Sterilization of the female using my special electrode and endothermic coagulation can be performed."

He does not mention having done this; however, he should receive credit for the first thought on the matter. Powers and Barnes of the University of Michigan in 1941 published a paper on their experience and histology of tubes fulgurated by using high-frequency, high-voltage pulsating current through a modified Ruddock peritoneoscope.¹⁴ In America aside from a few exponents, namely, Ruddock, Benedict, and Beling, peritoneoscopy was not accepted as a diagnostic tool.^{11, 15-17} However, in the European countries under the influence of Kalk many clinics and physicians used the technique extensively.

In 1952 a new apparatus developed by Fourestier, Gladu, and Valmiere revolutionized endoscopic techniques.¹⁸ They developed a method of transmitting an intense light along a quartz rod from the proximal to the distal end of the telescope. Previous sources of light consisted of lamps introduced into the cavity. This immediately removed the dangers of accidents due to electrical faults and heat and allowed intense light to be concentrated so that photographs could be taken. Endoscopic color films were produced, and in 1959 a closed-circuit television program was first produced by using the apparatus of Fourestier, Gladu, and Valmiere.⁵ Frangenheim in 1957 stressed general anesthesia, extreme caution in introducing the pneumoperitoneum, and avoidance of puncture through previous laparotomy scars. He further refined the optical instruments, and the laparoscope of Frangenheim is one of the standard optical instruments available today. Frangenheim published the first textbook on gynecologic laparoscopy in 1959.

In spite of these great advances in technique and safety very few clinicians in England and America were impressed by the procedure. In England, Handley, a general surgeon, described his experiences with peritoneoscopy and together with Nurick, in 1956, reported a series of 136 cases.^{19, 20} They were primarily interested in the liver, peritoneum, omentum, gallbladder, and stomach. They emphasized the ease with which the female organs could be studied. In 1962 Palmer of France used unipolar electrosurgery on the fallopian tube to effect permanent sterilization.¹⁸ The first International Symposium of Gynecological Endoscopy took place in Italy in 1964. In 1967 Steptoe of England published what he prefaces as the first book in the English language on laparoscopy.¹⁸ Publications in America By Fear²¹ and by Cohen²² in 1968 stimulated great interest in gynecologic laparoscopy.

It is very interesting to speculate why, with great advances in lighting and optics, laparoscopy was not used in America from the era of Ruddock (1930s) until almost the 1970s when it attracted the attention of gynecologists with great vigor. This can probably be attributed to their fascination and concentration on culdoscopy under the influence of Albert Decker of New York City.

Siegler and Berenyi's report in 1969 included 44 patients who had permanent tubal sterilization via laparoscopy.²³ In 1970, Peterson and Behrman published the results of 538 laparoscopies,²⁴ and Cohen published a textbook.⁵ Since laparoscopy was, so to speak, reintroduced into the United States in 1968 and with the improvement in lighting techniques utilizing fiber optics,²⁵ the widespread and extensive use of laparoscopy in the United States has been phenomenal.

A new organization, the American Association of Gynecological Laparoscopists, held its first annual meeting in 1972 with an attendance of over 600.²⁶ By March 1973, the association had received well over 500 applications for membership.²⁶ Their first International Congress of Gynecological Laparoscopy was held in New Orleans in November 1973. Laparoscopic sterilization quickly became the method of choice worldwide.

To attempt to chronicle the modern advances in laparoscopic surgery would be difficult at best. Even the appropriate terminology "operative laparoscopy" or "pelviscopy" has not been agreed upon. There have been, however, several major advances in laparoscopic surgery that are worthy of mention.

Stephoe and Edwards (1970) described the use of the laparoscope in oocyte retrieval, which pioneered the technology of in vitro fertilization.²⁷ Shapiro and Adler (1973) described the first case of an ectopic pregnancy removed via the laparoscope.²⁸ The tubal segment containing the ectopic gestation was completely excised, and bleeding points were endocoagulated.

Kurt Semm described techniques most commonly associated with operative laparoscopy. His endocoagulator allowed a safe means of controlling blood loss when performing laparoscopic surgery to treat endometriosis, pelvic adhesions, and removal of ovarian cysts and when performing salpingostomies.²⁹ His loop-ligation applicator and morcellation forceps enabled him to describe techniques for ovariectomy, adnectomy, and myomectomy.³⁰ He has truly pioneered the modern techniques of operative laparoscopy.

In the late 1970s several investigators described laparoscopic techniques to treat infertility via the laparoscope. Gomel treated pelvic adhesions and tubal occlusion with salpingolysis,³¹ sharp adhesiolysis, and neosalpingostomy,³² while Mettler et al. used endocoagulation for pelvic endometriosis and ovariolysis-salpingolysis for pelvic adhesions.³³

Techniques for managing ectopic pregnancies via the laparoscope also advanced rapidly. Soderstrom (1975) used a snare loop to excise an ectopic pregnancy,³⁴ while Bruhat et al. were the first to describe a laparoscopic linear salpingostomy with tubal aspiration.³⁵ In the early 1980s the laser was added to the surgical armamentarium. Bruhat (1980), Tadir (1981), and Daniell et al. (1982) initially described the use of the carbon dioxide laser.³⁶⁻³⁸ Keye et al. (1983) used an argon laser to treat pelvic endometriosis,³⁹ and Lomano (1985) described photocoagulation of pelvic endometriosis with Nd:YAG laser therapy.⁴⁰

Laparoscopy has also been used to treat traditional surgical conditions. Semm (1983) performed the first appendectomy through a laparoscope.⁴¹ The first cholecystectomy (with or without laser technology) was described in 1989.⁴²⁻⁴⁴ The laparoscopy has recently been used to perform some rather unconventional laparoscopic procedures. Letterie et al. (1988) treated prolapsed fallopian tubes with a combined laparoscopic-vaginal approach.⁴⁵ Nezhat et al. (1989) removed a dermoid cyst via the laparoscope.⁴⁶ Reich et al. described a laparoscopic hysterectomy⁴⁷ and the management of stage I ovarian cancer⁴⁸ through the laparoscope. Finally, chronic pelvic pain can be treated either by laparoscopic uterine ablation⁴⁹ or laparoscopic presacral neurectomy.⁵⁰

What has been witnessed has been a remarkable advancement of laparoscopic surgical techniques in recent years. What once were considered primarily open abdominal procedures are being performed partially or exclusively through the laparoscope. There are many advocates of these advances in laparoscopic technology. The patient avoids a large abdominal incision, and the hospital stay is shortened, as is postoperative convalescence, which decreases medical cost. However, these techniques are time-consuming and require a larger expenditure