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Degrees of Freedom

Advances in Gynecological and Obstetrical Surgery

by KARL C. PODRATZ, MD, PHD, FACS

The development of gynecological and obstetric surgical procedure has not taken place in a void. As in every other field of medicine, parallel developments in the understanding of human physiology, pharmacology, nutrition, intensive care, instrumentation—even electricity—have provided the synergy to make advances possible. Nothing, however, has been more important than the imagination and determination of individual surgeons who pioneered new techniques and created new tools. Their dedication has given modern women and the specialists entrusted with their gynecological and obstetrical care greater degrees of freedom than ever before.

Laparoscopy

Laparoscopy (more broadly endoscopy) has its origins in the quest for an efficient, minimally invasive way to inspect the abdominal cavity. In 1910, not long before the founding of the American College of Surgeons (ACS) in 1913, Hans Christian Jacobaeus, a Swedish internist, performed the first laparoscopic procedures. His paper reported his findings in the abdominal cavities of 19 patients using an endoscopic approach, which he subsequently termed "laparothorakoscopie."

Bertram M. Bernheim, MD, of the Johns Hopkins Hospital, was the first to introduce laparoscopy in the United States, performing the procedure at Hopkins in 1911. He actually published his experiences prior to learning of Jacobaeus' work, terming the procedure "organoscopy." Dr. Bernheim's work, and his reporting of a high diagnostic success rate, helped catalyze American interest in laparoscopy.

During the 1920s and '30s, advances in laparoscopy were chiefly centered on the development of equipment including wider angle lenses, trocars for port introduction of instruments, and insufflation devices. As crude as they were, these devices facilitated the progress that would be made over the next 40 years.

For example, in the 1930s, a Hungarian internist by the name of Janos Veress developed and improved the insufflation needle invented by Otto Goetze in 1921 by means of adding a spring that enabled safe insertion and insufflation (inflation) of the peritoneal cavity. It could also be used for draining ascites and evacuating fluid and air from the chest and remains an essential tool today.

Perhaps the most important pioneer in gynecologic laparoscopy was Raoul Palmer, a French gynecologist. He was instrumental in emphasizing the importance of monitoring intra-abdominal pressure during the procedure and used the Trendelenburg position to maximize visualization of pelvic structures. He began performing laparoscopic operative procedures for infertility diagnoses in German-occupied Paris during World War II, further developing it through the 1940s. Through his efforts, and following publication of his work in 1947, gynecologists began routinely using laparoscopy for tubal sterilization, lysis of adhesions in the abdomen, aspirations of ovarian cysts, and retrieval of ova from the ovaries.

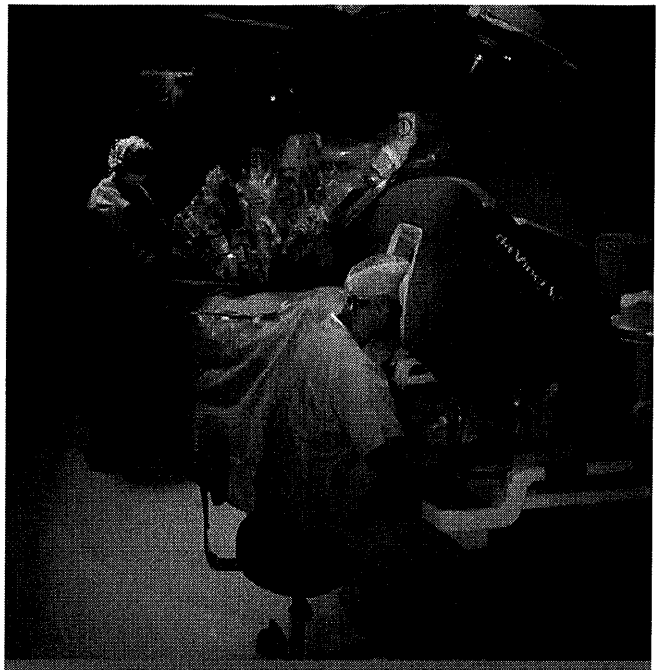
In the 1950s, the simple improvement of illumination expanded laparoscopy. Palmer introduced a safer light source by placing a small quartz-electric light bulb at the tip of a laparoscope, which increased brightness and decreased the chance of burns. Fiber-optic lighting technology was a natural follow-on. A wider range of gynecologic operative laparoscopic procedures were performed in Europe than in the U.S. in the 1960s, including the first laparoscopic appendectomy, performed by German gynecologist Kurt Semm.

Semm's laparoscopic appendectomy met with a significant amount of criticism and even disbelief from fellow surgeons, but he was undeterred. He designed an improved automatic insufflator and thermocoagulator (preventing tissue from burning during laparoscopic sterilization), further demonstrating that gynecologists were at the forefront of laparoscopy development.

The treatment of ectopic pregnancies via laparoscope began in the 1970s and early '80s, abetted by the introduction of new television, video, camera, and light-source technologies. Technological development in turn inspired new techniques, and in 1981, the American Board of Obstetrics and Gynecology required laparoscopic training to be a component of residency training.

The first video-laparoscopic cholecystectomy was performed in 1987 by Dr. Philippe Mouret in Lyons, France. Five years later, Camran Nezhart reported the first laparoscopic radical hysterectomy and lymphadenectomy. Considered the "father" of operative video laparoscopy, Nezhart's advances were bolstered by use of the first robotic arm in laparoscopy to hold a camera/instruments in 1994. Subsequently, several generations of robot systems have been developed. The fully articulating instruments simulate the full range of motion of the surgeon's wrists and hands, and offer the advantage of three-dimensional, high-definition imaging and magnification.

The degrees of freedom now possible inside the abdomen with robotic instruments have made a marked difference in approach. Robotic laparoscopy now facilitates hysterectomy, myomectomy, ectopic pregnancy, oophorectomy, and oncologic procedures including radical hysterectomy and exenteration.



With the da Vinci Surgical System, a surgeon controls robotic arms from a console to perform complex and delicate procedures through very small incisions with increased vision, precision, dexterity, and control.

Pelvic Exenteration

Cancer of the cervix accounted for a significant percentage of the gynecological cancers during the first half of the twentieth century. Most were treated with radiotherapy but recurrence was all too common. Typically, the recurrent cancer invaded locally adjacent organs including the rectum, bladder, and vagina. Chemotherapy was essentially unavailable and additional radiotherapy was ineffective. As such, the only reasonable option was surgery.

The potential for survival existed if these central pelvic tumors could be removed with wide margins of tissue clearance including surrounding organs, a procedure called pelvic exenteration. Unfortunately, it was recognized that with limited contemporary antibiotics, blood replacement, and intensive care, rates of survival would be prohibitively low. Thus the procedure wasn't attempted until Alexander Brunschwig, MD, embarked on a phase I trial.

Born in Texas and trained in Boston, France, and Chicago, Dr. Brunschwig performed the first total pelvic exenteration in New York in 1947. He sympathetically performed the procedure, considered by some at the time to be an abusive, mutilating operation, on 22 terminal patients with disease confined to the pelvis. Still, Dr. Brunschwig's pelvic exenterations for patients with cervical and reproductive-tract cancers realized a modest salvage rate (12 percent) when other options did not exist. That did not prevent the surgical community from criticizing him due to a surgical mortality rate of 23 percent.

The initial keys to successful pelvic exenteration lay first in determining which target lesions were appropriate for surgery and second, in finding a method of substitution for urinary bladder function following the removal of the bladder, uterus, vagina, and rectum.

Along with others, Dr. Brunschwig helped identify lesions suitable for surgery and sought solutions suitable for urinary diversion. Eugene Bricker, MD, who had been involved with pelvic exenterations at Barnes Hospital in St. Louis, MO, in the 1940s, reported his success with the construction of an ileal conduit that afforded low-pressure drainage of urine into an appliance attached to the abdominal wall.

In 1950, an ileostomy patient by the name of Herman W. Rutzen constructed a prototype of a rubber bag that could effectively form a watertight seal with the skin. Dr. Bricker tried the so-called "Rutzen bag" on two patients at the Veterans Administration Hospital in St. Louis with results so promising that he suspended his own work on a bladder substitute. Ruzten's device and Dr. Bricker's application of it had a major, positive impact on morbidity with pelvic exenteration.

These pioneering advances have been complimented by further advances in bladder substitution (the Kock and Miami pouches), better diagnostic techniques, and the employment of robotics. Though pelvic exenteration remains a very extensive procedure for women undergoing it, there has been a substantial improvement in longevity with five-year survival rates approximating 55 to 60 percent. There has likewise been a dramatic improvement in the quality of life for those undergoing the procedure, with new techniques in pelvic floor reconstruction, colonic reanastomosis, neovaginal reconstruction, and continent urostomy.

Cytoreductive Surgery

Epithelial ovarian cancer accounts for the majority of deaths from cancers of the female reproductive tract in the U.S. According to estimates, 22,280 new cases of ovarian cancer will be diagnosed in 2012 and approximately 15,500 deaths are anticipated. While chemotherapy and some biological agents are important treatments, surgery remains central in the diagnosis, staging, and primary treatment of this disease. Fallopian tube and primary peritoneal cancers present in similar fashion and are likewise managed with cytoreductive surgery.

These cancers spread in a similar manner, primarily through exfoliation. Cells exfoliated from the surface of these cancers are carried throughout the peritoneal cavity by the abdominal fluid. The cells commonly seed the diaphragm, omentum, and multiple other organs as well as the peritoneum and serosal surfaces of the bowel. As tumors grow, more cells are progressively shed, expanding the tumor burden within the abdominal cavity. Patients

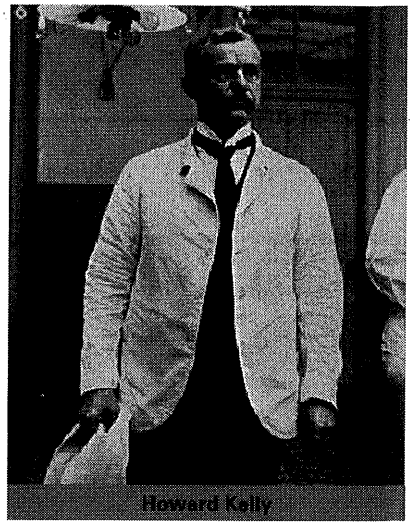
frequently present with malignant ascites and pleural effusions.

Cytoreductive surgery refers to the surgical excision of tumor and tumor-involved organs with the intent of minimizing the amount of residual disease remaining at the completion of the operative procedure. Optimal cytoreduction is removal of all visible disease. At a minimum for women having completed childbearing, this requires removal of the ovaries, uterus, fallopian tubes, omentum, and regional lymph nodes. With advanced disease, excision of the peritoneum, spleen, bowel, and other adjoining organs may be necessary.

Prior to the 1970s, cytoreductive surgery was not considered a viable procedure. Because of the limits of contemporary chemotherapy, patients who presented with advanced ovarian cancer (typically 70 percent) were not considered curable. For women who demonstrated extensive disease throughout the abdominal cavity, surgery was generally limited to removal of the primary tumor site.

But in the early 1970s, C. Thomas Griffiths, MD, studied the effect of tumor "debulking" on survival in 102 patients with advanced ovarian cancer. He reported that surgical cytoreductive procedures were associated with improved survival rates. Despite skepticism, Dr. Griffiths demonstrated that if all tumor tissue in the abdomen could be removed, patients had a survival rate of 39 months. If the tumor could be reduced to 5 millimeters or less, patients survived 29 months on average. If the remaining tumor was between 5 and 15 millimeters, the survival rate was 18 months.

As a result of Dr. Griffiths' work, the value of cytoreductive surgery was recognized and, over the years, further verified. Combined with more effective chemotherapy, the procedure currently results in survival rates approaching 100 months if all macroscopic disease can be removed. As before, the larger the remaining tumor mass, the lower the survival interval. But today, gynecological oncologists approach ovarian cancer much more aggressively, resulting in survival rates improved by a factor of three to four over the 1970s.


Howard Kelly

Surgery for Stress Urinary Incontinence

Chronic ailments have benefited from the development of gynecological surgical procedures, too. Stress Urinary Incontinence (SUI) has long been a source of physical, emotional, and social distress for women that surgery has sought to alleviate. SUI is essentially the loss of varying amounts of urine from movements that increase pressure within the abdomen and on the bladder, such as coughing, sneezing, or exercising. Technically, it stems from the loss of support of the urethra and bladder neck. It is generally caused by changes commonly associated with pregnancy, childbirth, strenuous work-related activities, and loss of estrogen support.

Surgical techniques for the cure of SUI were not introduced until the late nineteenth century. The first truly successful procedure was pioneered in 1900 by Howard Kelly, MD, a urogynecologist at Johns Hopkins. Dr. Kelly performed a plication (folding) of the bladder neck and proximal urethra by means of a deep mattress suture and anterior colporrhaphy (repair of the anterior vagina after plication). In 1914, Dr. Kelly presented a detailed analysis of outcomes for 20 patients. The "Kelly plication" remained the standard of care for more than 50 years thereafter.

The next significant advance emerged in 1949 when Drs. Victor Marshall, Andrew Marchetti, and Kermit Krantz introduced the cystourethropexy and colposuspension procedure, also referred to as the MMK procedure. The MMK procedure (in simple terms, bladder neck suspension/support surgery) was subsequently modified in 1961 by Vanderbilt Medical School professor John C. Burch, MD. Dr. Burch's modification involved placing surgical sutures at the bladder neck and anchoring them to the Cooper ligament. Gynecological surgeons used both the MMK and Burch procedures in the decades that followed, with SUI cures nearing 85 percent.

More recently, "sling" procedures have become the surgical interventions of choice for SUI. The sling is basically a narrow ribbon, typically made of synthetic material, which is placed beneath the urethra in minimally invasive fashion with minute incisions and inserted via a trocar. The sling placement augments deficient pelvic floor muscles by providing a hammock of support under the urethra.

A variety of slings, including the tension-free transvaginal tape (TVT) and transobturator tape (TOT) types, are currently in use, and studies have shown them to be approximately 85 percent effective. More recent

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developments aim to minimize the operative procedure as much as possible to reduce complications.

Fetal Surgery

The delicacy and complexity of childbearing have meant that obstetrical surgical practices have historically been limited to post-birth procedures. With the advent of fetal surgery or fetus-in-utero intervention, a fundamentally new (still nascent) channel of obstetrical surgery has opened.

The practical drivers of such change have been technological. The development of safe, non-invasive fetal imaging, monitoring, and sampling techniques has led to an increasing number of fetal anomalies diagnosed prior to birth. While some of these anomalies were understood before the application of these technologies, acceptance of the potential of fetal surgical and/or fetoscopic interventions accelerated after such approaches became more adaptable.

Physiologic observation of the mammalian fetus began with the examination of animal (guinea pig) fetuses in the nineteenth century. By 1920, the first scientifically successful nonhuman fetal procedures had been performed, studying aspects of fetal movements and experimental in utero manipulation. In the 1930s and '40s, observation of and operations on the lamb fetus gained momentum, proving the most productive fetal experimental model for decades thereafter.

In the 1950s, South African surgeons Dr. Christiaan Barnard (who performed the first successful human heart transplant) and Dr. J. H. Louw produced intestinal atresia (narrowing or absence of portions of the intestine) similar to that seen in human fetuses by interrupting blood supply in fetal puppies. The experiment established the pathogeneses of neonatal intestinal atresia and, as importantly, demonstrated the feasibility of simulating human birth defects by appropriate fetal manipulation.

The 1960s and '70s saw experimental fetal surgery used to simulate human congenital anomalies and for the study of normal developmental physiology and the pathophysiology of congenital defects. Experimental fetal surgery in primates proved more difficult as uterine contractility and preterm labor were more difficult to control. However, advances in surgical and anesthetic techniques and in the pharmacologic control of labor made experimental manipulations of the primate fetus possible, setting the stage for human fetal procedures.

The procedure that inaugurated human fetal intervention was performed by New Zealand surgeon Sir William Liley, who attempted to transfuse the fetus in utero in 1963. His successful intra-abdominal infusion of blood ameliorated Rh disease in a fetus expected to die before birth.

In 1981, the first open fetal surgery was undertaken at the University of California, San Francisco (UCSF) by a team including Michael Harrison, MD. In the operation, a vesicostomy was placed in a fetus with a urinary obstruction. Though the fetus did not survive, the procedure was a technical success and was complimented by the first successful sonographically guided placement of a fetal urinary catheter at UCSF the same year. The fetus survived this less extensive intervention and the adult continues to communicate with the university team today.

Despite these successes, few conditions (congenital diaphragmatic hernia, lower urinary tract obstruction, lesions of the thorax) met the criteria for fetal surgery that were set by consensus during this period and endorsed by the International Fetal Medicine and Surgery Society. As a result, very few open fetal procedures were attempted in the following decades, and by the 1990s, a shift to in utero endoscopy was under way, particularly in Europe.

Minimally invasive endoscopic fetal surgery poses less risk to the fetal patient and mother. The first clinical fetoscopic surgeries were interventions on the umbilical cord and placenta. Clinical trials also demonstrated the potential of fetoscopic therapy for twin-twin transfusion syndrome (disproportionate blood supply).

Future fetal interventions are likely to remain minimally invasive and center on prenatal gene therapy and stem cell treatments. Recent trials in the prenatal treatment of open spina bifida (myelomeningocele) at the Children's Hospital of Philadelphia, Vanderbilt, and UCSF have shown promise as well.

The advancement of the surgical arts and their compliments in the century since the founding of the ACS have not only improved the mortality of patients but raised their quality of life as well. New technologies, techniques, and clinical philosophies have given modern gynecological and obstetrical surgeons greater degrees of freedom than their predecessors envisioned. ■

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