

Chapter

1

A History of Modern-Day Video Surgery with and without Robotic Assistance

Barbara Page, Nataliya Vang, and Angie Tsuei

One of the most significant advancements in modern medicine has been the shift away from large incision “open” surgeries to video-assisted endoscopy, a groundbreaking innovation invented and pioneered by Camran Nezhat, MD, in the late 1970s.[1–4] Initially referred to as “keyhole,” “Band-Aid,” video surgery, or video laparoscopy, video-assisted endoscopy and video-assisted thoracoscopy (VAT) are now universally referred to as “minimally invasive surgery” (MIS), with or without robotic assistance. Dismissed as a barbaric and dangerous gimmick just 30 years ago, today MIS is recognized for profoundly improving the health outcomes of hundreds of millions of patients around the world. Indeed, with countless lives saved and millions of hospitalizations and surgery-related permanent disabilities prevented, the transformative impact that MIS has had on patients has been so remarkable that it has been described as a change to surgery as revolutionary for our era as anesthesia was for the nineteenth century.[1–4]

Unanimously Hailed as the Gold Standard

Today, the minimally invasive method of video-assisted endoscopy is recognized throughout the world as the unequivocal new gold standard in essentially every discipline of surgery.[5–14] Even for procedures like bowel resection, traditionally dominated by large incisions as the standard of care, a dramatic shift eventually occurred by approximately the mid-2000s, with leading authorities like the *New England Journal of Medicine* in 2004 finally acknowledging that open abdominal surgery for bowel resection should be converted to minimally invasive approaches, the same procedures that were called barbaric when Camran Nezhat, Farr Nezhat, and their team developed it.[15,16] Notably, too, in oncology, pediatrics, and emergency medicine – where MIS had been staunchly contraindicated for most of the twentieth century – a remarkable reversal has taken place as well, as practitioners in these fields are now urging their peers to phase out over-reliance on large incision open surgeries in favor of MIS [17,18] (Figure 1.1).

In the context of our modern understanding, MIS may appear as an evolutionary inevitability akin to the natural progression of humans walking upright. However, a retrospective examination reveals that reaching this pinnacle of acceptance almost didn’t survive the intense academic conflicts that erupted for calling into question 170 years of established surgical norms and asserting that large incisions were no longer optimal care. More than this, the new surgical reality brought to light that, in many cases, large incisions were not just unnecessary but also

posed risks of increased chronic pain, morbidity, and even mortality compared to the original illness.

Yet, the practical reality was that asking established surgeons to abandon all that they knew and relearn how to perform surgery from a TV monitor through tiny portholes using “long sticks” was viewed as not only entirely scandalous but too risky to attempt. This was especially true during the 1980s for very advanced procedures like laparoscopic treatment of multi-organ stage IV endometriosis, including management of endometriosis of the bowel, bladder, ureter, diaphragm, and so on, that were being performed by Drs. Camran and Farr Nezhat and their team.[16,19] This also came at a time when early reports of miraculous outcomes – of blood loss measured in teaspoons instead of cups, of patients returning home within hours after major surgery instead of after days or weeks in the hospital – were still being largely dismissed by academic medicine as utter impossibilities. It wasn’t long, however, that disbelief devolved into false accusations that the early pioneers were hiding their complications or fabricating their results. In other words, rather than seeing MIS as the future of surgery, what most saw was an innovation that appeared to be not only unnecessary but also a dangerous deviation from established norms without any possible present or future value.



Figure 1.1 Dr. Nezhat and fellows in the simulation lab.

Barbara Page, Nataliya Vang, and Angie Tsuei

Faced with such an impenetrable fortress of resistance, for many years, it proved exceedingly difficult to convince anyone that MIS could – or should – replace traditional open surgeries (Figures 1.2 and 1.3).

Diagnostic & Early Forms of Therapeutic Laparoscopy

To get a better understanding of just how stacked the odds were to have overcome such seemingly insurmountable obstacles, it's helpful to step back and evaluate the surgical landscapes of both gynecology and general surgery as they stood during the formative years of the late 1970s and early 1980s when modern-day video laparoscopy emerged. Something that is not so clearly spelled out in other historical accounts is that there was actually already significant skepticism in the late 1970s concerning the use of pre-video laparoscopy in surgical applications. In fact, many historical accounts erroneously suggest that gynecologists, in particular, had “fully embraced” pre-video laparoscopy as a standard modality by the 1970s.[5,20] While there is a grain of truth to this, with respect to diagnostic laparoscopy and some minor therapeutic indications, for advanced operative procedures, the story was quite different.

To understand this paradox, it's also critical to step back in history even further and consider the separate histories of video laparoscopy's two most important predecessors: diagnostic laparoscopy and operative laparoscopy. Diagnostic endoscopy and laparoscopy have antecedents stretching back as early as the sixteenth century, when polished metal reflectors, combined with modified tubes or specula, were used to attempt visualization of internal body cavities. However, most regard Philip Bozzini's 1806 introduction of a (relatively) more sophisticated system as the beginning of modern-day diagnostic endoscopy. [21] Yet, for most of modern history, applying the endoscope abdominally (laparoscopy) proved far too treacherous an enterprise. This meant that, for centuries, the body's most critical organs could not be viewed or easily accessed through minimally

invasive means. While some attempts of diagnostic laparoscopy from the nineteenth century and even earlier have been reported, most consider the German gastroenterologist Georg Kelling as the first to successfully utilize an abdominal approach when he viewed the abdomen of an anesthetized dog in 1901 with what was referred to as a coelioscope and later performed this new minimally invasive diagnostic technique on a small series of patients.

Regarding laparoscopy's operative history prior to video, French urologist Antonin Desormeaux is often acknowledged as the first, in 1853, to conduct a large series of clinically successful therapeutic cystoscopic procedures guided by true endoscopic visualization. However, it wasn't until 1910 that the first successful minor *operative* laparoscopic procedure would be achieved by Swedish internist Hans Christian Jacobaeus, who was the first to coin the term *laparoscopy* and went on to laparoscopically lysed adhesions in the abdominal cavities of 17 patients and in the chest area of 2.

Thereafter, a new generation of laparoscopic pioneers from around the world emerged, including Drs. Abbot Beling, Bertram Bernheim, Edward Benedict, Boesch, Karl Fervers, Heinz Kalk, Roger Korbsch, Severin Nordentoeft, B. H. Orndoff, Raoul Palmer, Richard Telinde, and John Ruddock, who performed simple therapeutic and diagnostic laparoscopic procedures in the pre-video era of the early twentieth century. In fact, the field had gained enough acceptance as a predominantly diagnostic modality that Roger Korbsch published in 1927 what is believed to be one of the first textbooks on the subject.[22–24]

From this field of acclaimed innovators, the work of Heinz Kalk stands out in particular, earning him the honor as the founder of the German school of laparoscopy. Kalk's achievements at the time were legendary and include technical innovations as well as groundbreaking publications, including his 1939 article reporting a series of 2000 liver biopsies with no fatalities. In the US, John Ruddock was also one of the most advanced laparoscopic pioneers of his era, whose contributions also included technical improvements to his newly designed peritoneoscope,



Figure 1.2 Open surgery. (Image courtesy of Dr. Ari Leppaniemi, Chief of Emergency Surgery, Helsinki University Hospital Meilahti, Finland, and World Journal of Emergency Surgery, BioMed Central.)

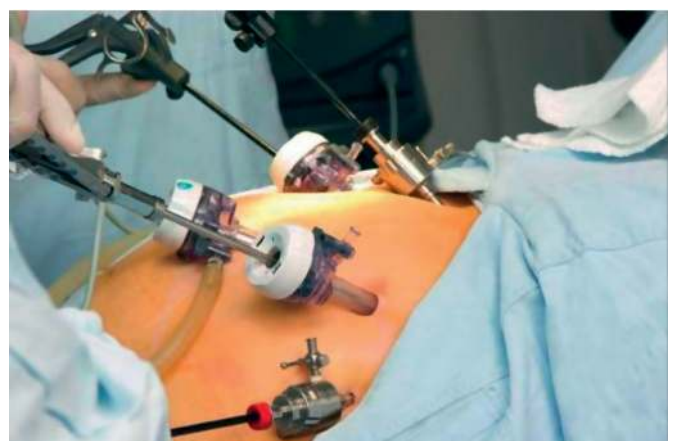


Figure 1.3 Modern-day surgery. It stunned Nezhat to realize how outraged others were with his “after” version of surgery, even though it was associated with lowered morbidity and significantly less pain than traditional open surgeries like the one shown in the “before” image. (Image from iStockphoto.com.)

which was successfully utilized in 200 patients by 1934. Throughout the 1930s, Ruddock was also one of the most vocal in imploring others to incorporate diagnostic laparoscopy as a way to avoid the exploratory laparotomies that were rising in popularity at the time, but which he bluntly stated “should be condemned.” To help persuade his colleagues, Ruddock offered some of the earliest statistics, reporting that, in his experience, clinical diagnoses had an error rate of 48%, compared to just 6% with diagnostic laparoscopy. By 1937, Edward Benedict reported on the laparoscopic aspiration of a large ovarian cyst on an 85-year-old patient. Benedict’s general techniques were similar to those prevailing at the time, such as the use of two trocar sites, atmospheric air to insufflate the abdomen, and relying only on local anesthesia in conjunction with sedative drugs. Although Korbsch introduced an insufflation needle in 1921, it was in 1938 that Janos Veress significantly improved the technology with his spring-loaded version with a beveled point for cutting through tissue. As the field expanded, formalized reporting of contraindications emerged, with Beling providing one of the most extensive reviews of the literature in 1939. By 1943, internationally recognized pioneer Raoul Palmer entered the field and began performing diagnostic and simple therapeutic laparoscopies in Occupied Paris during World War II, including biopsies and lysis of adhesions for gynecologic conditions. Using a modified McCarthy cystoscope, coupled with redesigned insufflators that he designed and initially built himself, Palmer placed patients in the Trendelenburg position for better pneumoperitoneum and was one of the earliest to recognize the importance of careful monitoring of insufflation. Medical historians now regard Palmer as a pioneering figure in laparoscopy, having produced the most significant published work on the application of the technique in women’s medicine during that era.

Concerns about Over-Enthusiasm

Throughout this early-twentieth-century time frame, interest in this exciting new field was reportedly so heightened that concerns about over-enthusiasm began to surface. However, the euphoria was short-lived, as reports of potentially serious and sometimes fatal complications quickly circulated. Given the abundance of vital organs, veins, and arteries in the abdomen, all forms of laparoscopy initially faced significant morbidity and mortality rates. Setting aside the small number of early pioneers with outsized skills, the vast majority of practitioners would never be able to reach this level of expertise. Progress was also severely curtailed due to the outbreak of World War II. The end result was that diagnostic and therapeutic laparoscopy gradually faded into relative obscurity, essentially abandoned by the majority of US practitioners by the 1950s, with just a handful of virtuosos continuing to defy the odds. This shift was also influenced by the increasing safety of open abdominal procedures, making them not only the preferred operative approach but which also allowed for the notorious exploratory laparotomy to continue as a favored diagnostic modality for much of the second half of the twentieth century.

With both diagnostic and operative laparoscopy now viewed as too dangerous to pursue further, it would take

years to revitalize the same level of interest in the field that had enthralled the world just a couple of decades earlier.

Laparoscopy Revival of Interest during the 1950s–1970s

It was only after the introduction of crucial technologies in the 1950s–1970s, coupled with the advocacy work by the era’s acclaimed practitioners to keep the field alive, that a modest resurgence of interest in all forms of endoscopy emerged, particularly in gastroenterology and gynecology.[25–27] Our team covered a more complete history of the legendary pioneers of laparoscopy of the 1950s–1970s in *Nezhat’s History of Endoscopy*, but some of the most preeminent include Drs. Henk De Kok of the Netherlands, Victor Gomel of Canada, M. A. Bruhat of France, Jacques Donnez of France, Carl Levinson of the US, Kurt Semm of Germany, Hubert Manhes of France, Hans Frangenheim of Germany, and Patrick Steptoe of England, as well as continued innovations by Palmer.[28]

One of the most spectacular moments arrived in 1958 when Frangenheim produced his famous color film of a laparoscopically captured ovulation in progress, a feat that would reverberate throughout the world of gynecologic surgeons for years to come.[29] Although Palmer had presented one of the world’s first color films of a laparoscopic procedure earlier, in 1955, it was Frangenheim’s captivating milestone in particular that catalyzed a wave of renewed interest in laparoscopy’s capabilities.

In terms of operative progress, numerous gynecologists continued the work of pre-war pioneers in laparoscopic sterilizations. Notably, British physiologist and future Nobel Prize winner Dr. Robert Edwards and his gynecologist collaborator, Dr. Patrick Steptoe, were pioneers in this field. Dr. Steptoe routinely performed laparoscopic tubal ligations, utilizing the two-puncture technique, during the 1950s and early 1960s. His expertise in laparoscopy proved instrumental when he applied his skills to retrieve oocytes, ultimately leading to the birth of the first in-vitro fertilization (IVF) baby, Louise Brown. Throughout this same period, Jacques Donnez and his team were also instrumental in advancing laparoscopy in the field of IVF.

Perhaps more than anyone, the legendary Dr. Kurt Semm defined the era and advanced the field tremendously, with several innovations and over 1000 publications. Renaming laparoscopy as “pelviscopy,” Semm began developing newly designed instrumentation and techniques as early as 1960, including an improved automatic insufflator and innovations in laparoscopic suturing, which enabled him to perform procedures throughout the 1970s, including the first reports of pre-video laparoscopic ovarian cystectomy, as well as adenectomy and myomectomy.

By 1971, H. M. Hasson introduced “open laparoscopy,” which allowed for direct visualization of trocar entrance, a crucial innovation since trocar injuries were and continue to contribute to as much as 40% of mortality in laparoscopic surgery. In 1972, H. Courtenay Clarke introduced new laparoscopic suture techniques, performed operative procedures, and

Barbara Page, Nataliya Vang, and Angie Tsuei

designed and built newly improved instrumentation. As early as 1973, laparoscopic treatment of ectopic pregnancies was advanced and routinely performed by Bruhat of the University of Clermont-Ferrand in France, along with his colleagues Mage, Pouly, and Manhes, with Manhes developing several instrument innovations. Victor Gomel was one of the most prominent laparoscopic pioneers of the era as well and reported good results with infertility patients undergoing corrective laparoscopic surgery. By 1977, the first laparoscopic appendectomy was achieved by De Kok, who went on to publish one of the largest series of laparoscopic appendectomies at the time, followed by Semm, whose first laparoscopic appendectomy was performed in 1980. In 1979, Bruhat *et al.* introduced the CO₂ laser for laparoscopy, while Yona Tadir of Israel independently accomplished the same in approximately the same period. In the US, past president of the American Association of Gynecologic Laparoscopists (AAGL), Carl Levinson, was one of the most respected laparoscopists of the era for his work in advancing the field, including the laparoscopic treatment of ectopic pregnancies and management of various infertility conditions.

During this period, the establishment of pioneering organizations also emerged. In 1941, the American Gastroscopic Club, now known as the American Society of Gastrointestinal Endoscopy, was founded under the leadership of Rudolf Schindler, one of the most prominent figures in gastroenterology. Similar clubs were also taking shape in Europe, South America, and Asia. By 1959, the Japan Gastrocamera Society came into existence, marking the inaugural release of their society journal, *Gastroenterological Endoscopy*. In 1960, the European Endoscopic Club laid its foundation, serving as a precursor to the eventual establishment of the European Society of Gastrointestinal Endoscopy. Following closely thereafter, in 1962, the World Endoscopy Organization was founded. As for laparoscopy, Dr. Jordan Phillips founded the AAGL in 1971, marking a significant milestone. A decade later, in 1981, the Society of American Gastrointestinal Endoscopic Surgeons was established, further contributing to the evolution of endoscopy in multiple disciplines.

Through the tireless work of these early laparoscopic pioneers of the pre-video era, the volume of procedures being performed skyrocketed, with one source reporting that the number of tubal sterilizations performed laparoscopically increased from just 1% in 1971 to an astonishing 60% by 1976.[30] By 1981, pre-video laparoscopy training had also been incorporated into “all major gynecologic residency programs” in the US,[22] an incredible rate of change considering that, just a decade earlier, in 1972, there were only about 30 centers in the US where laparoscopic procedures of any kind were being performed.[31]

Video Laparoscopy's Technological Predecessors: TV, Film, Video, and Light Sources

In terms of technologies, there were also many important milestones being achieved. In fact, precursor component

parts to video laparoscopy had actually been developed decades earlier. Cinematography and television had been used modestly since the early 1940s, with US pioneers Frank Dolley and Lyman Brewer presenting in 1942 what is believed to be the first known color motion picture of a live bronchoscopy.[32] By 1950, Japanese pioneers Dr. Tatsuo Uji, Mr. Fukami, and Mr. Sugiura, in collaboration with Olympus, had developed the gastro-camera, the world's first miniaturized endoscopic camera for photography, about half the size of a nickel.[33]

Soon thereafter, some of the most sensational moments in endoscopy's history debuted, with the world's first television broadcasts of live bronchoscopies, achieved separately in 1955 by the French bronchoscopists A. Soulas and J. M. Dubois de Montreynaud.[34] As mentioned, Palmer and Frangenheim were also at the forefront of laparoscopy and color film, presenting their firsts in 1955 and 1958, respectively. By 1960, another significant advancement emerged with the introduction of the first commercially available flexible fiber-optic endoscope, co-invented by Basil Hirschowitz and Larry Curtiss in 1957. This groundbreaking technology played a pivotal role in propelling gastroenterology far ahead of other medical disciplines of its time.

Still, these systems were not designed with operative video-assisted endoscopy in mind. Even as late as 1977, an article summarizing the latest in endoscopic TV and video devices – back then referred to as “teaching attachments” – described these technologies as useful for teaching and documentation purposes only; there is no mention of changing the *method* of performing endoscopic procedures to advance its operative potential [31,35] (Figure 1.4). And, as the figures from this article illustrate, even though 1977-era laparoscopes were equipped with cameras, the era's most advanced laparoscopists, like Semm, were still using the endoscope in the



Figure 1.4 A catalog ad for a “teaching attachment,” circa 1960s, which is what laparoscopic camera systems were referred to before Nezhat's introduction of video-assisted endoscopy. The old way of performing laparoscopy.

A History of Modern-Day Video Surgery with and without Robotic Assistance



Figure 1.5 Dr. Berci, one of the pioneers performing laparoscopy in the late 1970s.[38]

traditional manner, hunched over and peering awkwardly through the eyepiece. Additionally, teaching attachments were limited, allowing only a limited number of participants to be involved in the learning process [36,37] (Figure 1.5).

Delayed: What Seemed Like an Endless Wait at Tubal Ligations

In other words, even with these cutting-edge technologies, it eventually became clear that pre-video laparoscopy was of limited utility for more advanced operative procedures. This was attributable to its seemingly inescapable, centuries-old design, which required surgeons to hunch over, squinting with one eye closed and one hand encumbered in order to view the surgical field directly through the small aperture of the scope. In this manner, there was no way for laparoscopists to avoid those infamous painful contortions they found themselves in just so they could obtain what amounted to no more than a negligible view of the anatomy. As a result, for the vast majority of surgeons, advanced operations with the laparoscope were essentially infeasible at best and perilous at worst (Figure 1.5).

Given so many seemingly insurmountable obstacles, it's easy to understand why progress toward more advanced laparoscopic procedures had essentially stagnated by the late 1970s, entrapped by imaginary boundaries beyond which it was forbidden to go. It wasn't too long ago, in fact, that most surgeons were aghast at the mention of using the laparoscope to remove even just ectopic pregnancies, let alone resecting the bowel. As for gynecology's operative laparoscopic superstar of the 1960s–1970s – tubal sterilization – its origins trace back to 1936 when Swiss surgeon Boesch performed the world's first documented laparoscopic tubal sterilization using electrocauterization.[30,39] Naturally, the technique underwent refinements over the years. Yet, by the close of the 1970s, conceptually, the procedure had not changed much from its 1930s debut.

Indeed, with the exception of the achievements of the era's inimical surgical superstars, in gynecology the entire discipline seemed stalled at the tubal ligation as if it were the final frontier. Even as recently as 1977, Semm received a decidedly

reserved reception at an AAGL medical conference where he demonstrated various operative laparoscopic procedures that he performed in the traditional manner of peering directly into the scope. “Kurt Semm's pelviscopy presentation struck people in that meeting as going too far,” recalls Richard Soderstrom, one of the founding members of the AAGL. And this was the response from one of the most welcoming societies in the world for laparoscopic innovation. With the debate titled “Laparoscopy Is Replacing the Clinical Judgment of the Gynecologist,” it was abundantly clear that advancing the scope beyond its prescribed therapeutic and diagnostic roles was simply too unsettling and unacceptable for most.[40]

Overcoming the Mythology of Laparotomy

Perhaps the greatest mythology to overcome was the nearly universal consensus that a large abdominal incision – laparotomy – was irreplaceable as a surgical modality. At the time, it was ingrained in the surgeon's mind that the bigger the surgery, the larger the incision should be. This was true, despite the many vocal protests from female patients, who had been insisting on vaginal entry surgeries for more than a century just so they could avoid laparotomies.[24] And even though surgeons too had been bemoaning its significant mortality rates since at least 1898, by about the mid-twentieth century, laparotomy's perceived benefits began to overshadow its formidable downsides, a change brought about by the introduction of antibiotics and safer anesthesia. Transformed now into a paragon of surgical virtue, its often serious complications were somehow downplayed as normal and necessary for the sake of saving a patient's life.

With classical surgery's large incision allowing ample room to view and palpate the internal viscera, to be free of any spatial confinements or depth-of-field distortions, to see in 3D and directly (as nature intended), attending to hemorrhages with the greatest of ease: these were all undeniable advantages for surgeons, believed to be crucial for the very survival of patients and thought to be unattainable by any other means. And, with the introduction of even more advanced medical adjuvants in the late twentieth century that made laparotomies even safer – improved anesthetics, intramuscular antibiotics, and anti-hemorrhagic agents – morbidity and mortality rates began to decline.

Meanwhile, microsurgery, a more refined version of large incision surgery, emerged as a popular modality. By the late 1970s, it was beginning to be touted as a possible panacea for all the flaws associated with the more traumatic “gross” laparotomy. Although microsurgery was still open surgery, only in disguise, nevertheless, at first glance, it actually had a lot to offer, apparently almost as much as video laparoscopy: a more comfortable operating position, magnification, and reduced damage to tissue, resulting in fewer adhesions. And, when applied to fertility surgery, spectacular results with microsurgery were reported, with purportedly doubled, even tripled, fertility rates commonly cited. Other sensational milestones soon followed, like the world's first vascularized fallopian tube transplant by Brian Cohen in 1975, achieved with the aid of microsurgical techniques. With rock star moments like these,

Barbara Page, Nataliya Vang, and Angie Tsuei

who needed a new surgical philosophy? The existing ones appeared to be working just fine.[40]

To be fair, such sentiments were understandable for much of the twentieth century when there were indeed few other choices for open surgery. The fact is that large incision surgeries during modern times saved more lives than they took, which is why attempting to define just who the real antagonist is in this story is not only futile but also an exercise that wouldn't provide much meaningful insight anyway. Rather, these historical vignettes provide a greater understanding of just how easily biases can slip past the scientific process and how beliefs can become "a form of blindness," even when they're slipping toward obsolescence.

By the time pioneers and patients alike began pushing for more advances in MIS, the surgical opinions that were being questioned had been viewed as nearly infallible truths for almost two centuries. However, prevailing opinions are only as good as the data that inform them. We assume that evidence-based medicine and the peer-review process will weed out the bad and usher in the good, but don't such systems fall apart if the right questions are not being asked in the first place? Even with the best of intentions, aren't clinical observations imperfect inputs, viewed as they so often are through the distorted lens of an observer's own flawed assumptions? These were the sorts of issues that had to be carefully considered in order to convince others that the time had come to reevaluate the surgical status quo (Figure 1.6).

Backlash to Laparoscopy for the Second Time in the Twentieth Century

As if these conceptual plateaus were not enough, gynecologic laparoscopy in the US experienced another season of discontent, just beginning to surface in the late 1970s. Growing concerns over complication rates associated with pre-video laparoscopic sterilizations began to surface. Although some aspects of the reporting were sensationalized, the unexpected rise in complications triggered a nearly instantaneous backlash against laparoscopy in general, as articles forewarning of its potential for serious mishaps began seeping into the medical literature and eventually the lay press. One of the first such articles to gain national attention was published in 1977 by the founder of the AAGL, Jordan Phillips. Phillips's exposé, which outlined in stark detail the estimated complication rates associated with laparoscopic tubal sterilizations, struck a raw nerve within surgical communities and served for a time to temper enthusiasm.[41]

Soon thereafter, urgent congressional hearings and other governmental advisory panels were called into session to address concerns about the rapid technological changes affecting endoscopic medical devices in particular and medical technologies in general. Symbolic actions were taken against all forms of endoscopy, beginning most conspicuously with the Medical Device Regulation Act, passed in 1976. Later, in 1981, the Centers for Disease Control and Prevention (CDC) in Atlanta issued a terse public rebuke over patient deaths apparently linked to unipolar electricity sources used in laparoscopic sterilizations.[42,43]

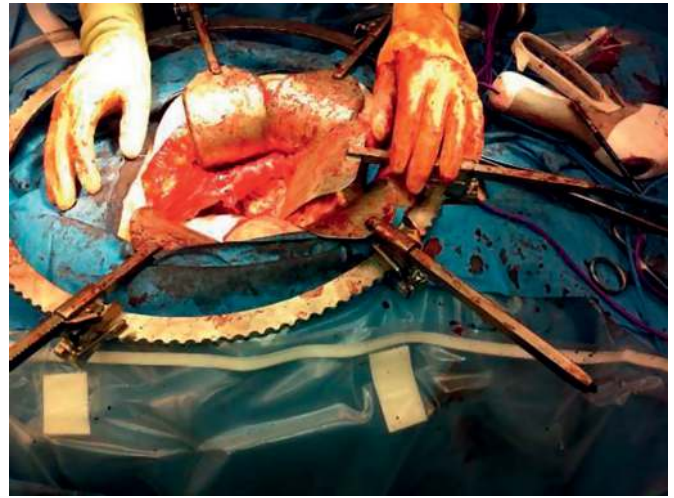


Figure 1.6 A recent image of a laparotomy, metal retractors and all.

Only a handful of physicians were swift to publicly advocate for this procedure in this time period. One in particular, Dr. Preston Williams, published an article in 1974 highlighting the recent increase in gynecologic laparoscopic complications, and attests this to the lack of proper training with the new-found technology. Williams advocates for a more structured and informed approach to disseminating these procedures in the field of medicine, stating that the generally accepted paradigm "do one, see one, teach one" was not sufficient in these cases.[44] Alternatively, Williams stresses that these complications are highly avoidable, and highlights the minutiae among each category of complications, and how to improve each one. Williams vehemently argues that if proper precautions are taken and these procedures adhere to a strict set of guidelines, the complication rates can be greatly decreased.[44] He further explains that the lack of mastering diagnostic laparoscopy is the downfall of surgeons attempting surgical laparoscopies, and that with more knowledge and instruction, patient safety can be protected. Despite this article being one in favor of the safe usage of laparoscopy, the nature of the lengthy paper accentuating all of the current drawbacks of this procedure was only a reinforcement to the public opinion: laparoscopic surgery is undertrained, unsafe, and unwanted by the medical community.

In such an environment of growing controversy, eventually, failed sterilizations became the second leading cause of lawsuits for obstetrician-gynecologists in the US. Since the medical community tends to err on the side of caution, such adverse reports – whether exaggerated or not – were nearly the death knell for endoscopic innovation in those days.

Operative Progress Ossified in Its Tracks

The impact of these growing controversies and lingering conceptual constraints are plainly evident when one reviews the literature and textbooks from the 1970s–1980s, which reveal that the laparoscopic procedures being performed were essentially no more advanced than those that had been introduced nearly 50 years earlier: draining cysts, lysing adhesions,

A History of Modern-Day Video Surgery with and without Robotic Assistance



Figure 1.7 A recreation illustrating the traditional method of performing laparoscopy, involving squinting and being hunched over.

biopsies, cautery of neoplasms, and tubal ligations.[45–51] For all of the most complex gynecologic pathologies that required surgery, large incision laparotomies remained the only surgical solution available to essentially most surgeons, as the work of Semm and other virtuosos unfortunately failed to be widely adopted due to the still insoluble issues of scalability and reproducibility. By the late 1970s, these same limitations of laparoscopy could be seen in general surgery as well, which had essentially advanced no further than liver biopsies, the same procedure that Kalk had mastered in the 1930s.

And so it unfolded that the revivalist heyday, which laparoscopists had so enjoyed during the post-war period, had been nearly neutralized by the end of the 1970s, leaving operative progress practically ossified in its early twentieth-century tracks. As is usually the case, it would be psychological resistance to change that proved to be the far more formidable element to overcome.

A Dream Is Born: The Introduction of Video-Assisted Endoscopy

Dr. Camran Nezhat simply could not reconcile what he was witnessing: the glaring inconsistencies of laparoscopy itself, fully actualized in its diagnostic domain, then bounding forward toward essentially just one operative procedure – tubal ligations – gynecologic laparoscopy's apparent operative endpoint. Meanwhile, progress toward other surgical procedures remained elusive rarities, isolated achievements performed by a few gifted outliers in just a few centers throughout the world. [29,35,36] It was a peculiar paradox to see the entire field stopping short of more advanced procedures that were so close anatomically. Seeing how quickly patients recovered from laparoscopies compared to laparotomies, it became inescapably clear that something was terribly amiss.

It seemed evident that one of the most significant hindrances thwarting laparoscopy's surgical progress was the awkward positioning it required. Whether in diagnostic or operative mode, the entire enterprise left everyone contorted in the most absurd positions, bent over sideways,

With camera attached, the surgeon's head and body are 4" to 6" farther away from his instruments: surgical reach is awkward.

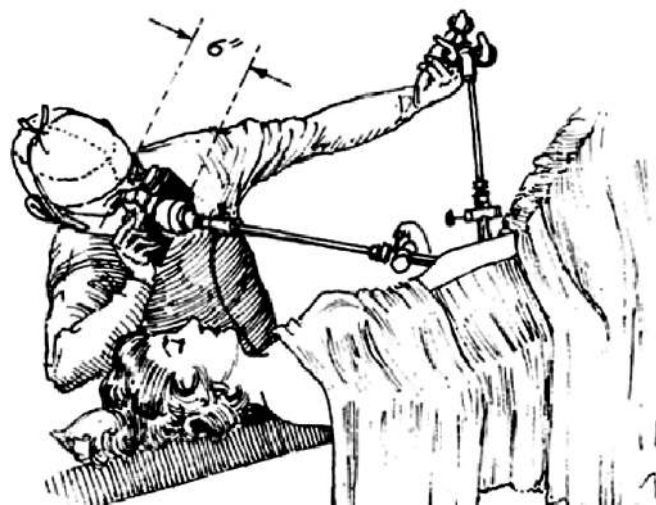


Figure 1.8 Another image showing the awkward angles required when performing laparoscopy in the old manner.

craning to peer down the scope's tiny aperture held by one hand, leaving only one free to perform procedures. It was essentially a futile enterprise (Figures 1.7 and 1.8). Nezhat knew that if he could just find a way to circumvent these physical constraints, more surgeons would be able to tap into endoscopy's true potential as an advanced operative force (Figure 1.9).

By the late 1970s, Nezhat figured out just the right configuration of positions and parts. Of course, numerous modifications and technical innovations had to be made, including the deployment of two laparoscopes instead of one in order to deliver more light to the abdominal cavity. With the two laparoscopes and two light sources, he could now see well enough to operate while looking at the images on the TV monitor (Figure 1.10). With the equipment thusly transformed, Nezhat began operating “off the TV monitor,” which became the defining factor that enabled him to perform the most advanced procedures video laparoscopically. The surgeon's two hands were now free, and both eyes could remain open now that squinting through an eyepiece was no longer necessary. Surgeons could also finally operate in a comfortable, upright position, which meant that operator fatigue no longer stood in the way of performing more lengthy and complex operations. And, with the entire surgical team able to see the surgery on the TV monitor, assistants could better anticipate the surgeon's needs (Figure 1.11). In 1982, he added a CO₂ laser to his instrumentation and called it video laser laparoscopy or video laseroscopy.

Barbara Page, Nataliya Vang, and Angie Tsuei

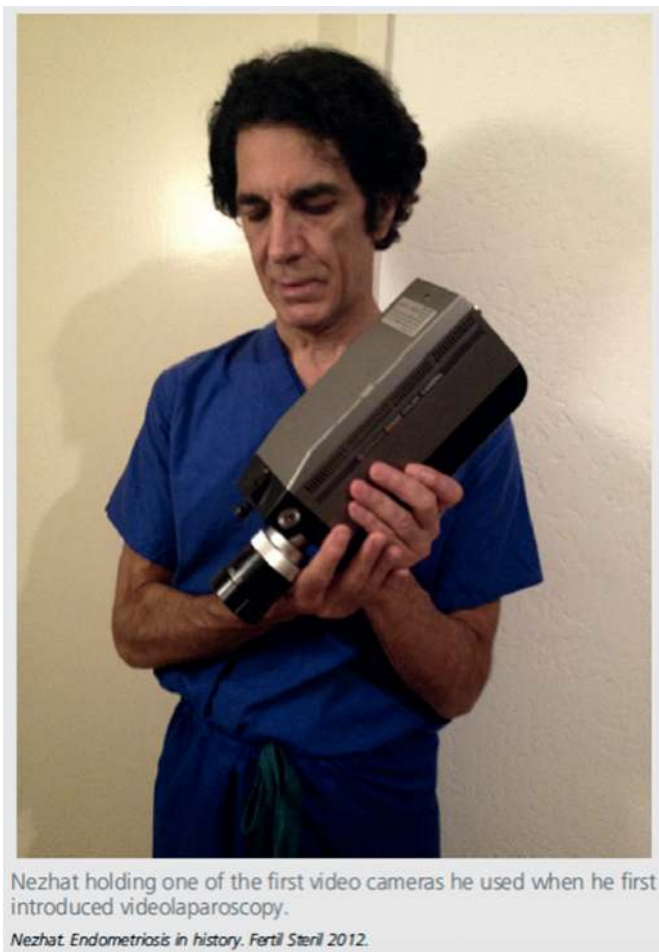


Figure 1.9 Dr. Camran Nezhat holding one of the first video cameras he used when he first introduced video laparoscopy.



Figure 1.11 Nezhat performing video laparoscopy, circa late 1970s – early 1980s: notice how large the video camera is compared to today's instruments. Given this initially cumbersome setup, most found it impossible to believe that video endoscopy would be the future of surgery, leaving many to wonder about Nezhat's sanity.

After this pivotal breakthrough, by the early 1980s, Nezhat was able to take on cases once deemed inoperable by the traditional pre-video laparoscope, pioneering for the first



Figure 1.10 Nezhat performing video laparoscopy; two scopes are used in the abdomen, one was purely used for delivery of light as the light sources were inadequate.

time video laparoscopic and truly comprehensive treatment of severe endometriosis involving major resections of multiple organs; complex cancer surgeries; bowel, bladder, ureter, diaphragm, lung, and liver resections and reanastomosis; pelvic and para-aortic node dissection and radical hysterectomy; ovarian remnant; sacral colpopexy; dermoid cyst removal; adnexal mass removal during advanced pregnancy; vesico- and rectovaginal fistula repair; and more.[16] During this period, his research faced repeated rejections from medical journals, leading Nezhat to shift his focus to teaching through postgraduate courses starting in 1982 and offered often biweekly at the Georgia Institute of Technology in Atlanta, Georgia, and Northside Hospital, in collaboration with Dr. Scott Crowgey. This educational endeavor continued at Stanford University Medical Center in Palo Alto, California (Figures 1.12, 1.13, and 1.14).

Over the subsequent two decades, more than 10 000 physicians and surgeons attended these postgraduate courses, seminars, or live demonstrations facilitated by Dr. Camran Nezhat and his team, including his brothers Drs. Farr and Ceana Nezhat. Notable attendees from various parts of the world included, alphabetically listed, David Adamson, Veasy C. Buttram Jr., Steve Carson, Donald Chatman, Alan DeCherney, Celso-Ramon Garcia, Victor Gomel, Linda Guidice, Harriet Hassan, Grace Janik, Ron Levin, Carl Levinson, Barbara Levy, Cy Liu, Frank Loffer, Tony Luciano, Dan Martin, William Parker, Resad Paya Pasic, Hosanna Phillips, Mary Lake Polan, Harry Reich, Alvin Siegler, Radha Syed, Ray Valle, and Paul Wetter, among others. Many of these individuals served as presidents of the American Society for Reproductive Medicine (ASRM) or the AAGL at some point.

A History of Modern-Day Video Surgery with and without Robotic Assistance

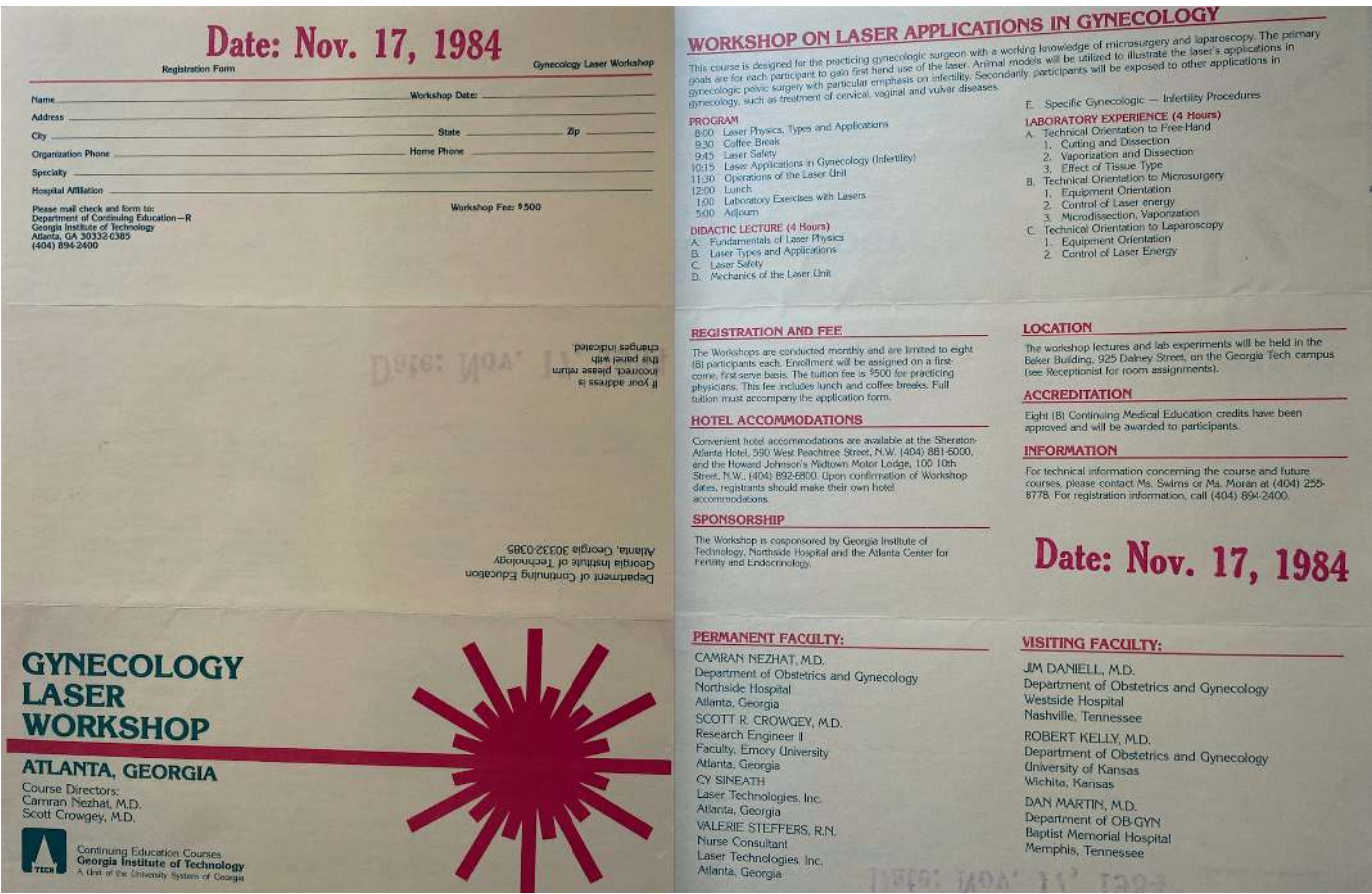


Figure 1.12 Brochure from a workshop on laser applications for gynecology directed by Camran Nezhat and Scott Crowgey in Atlanta in 1984.

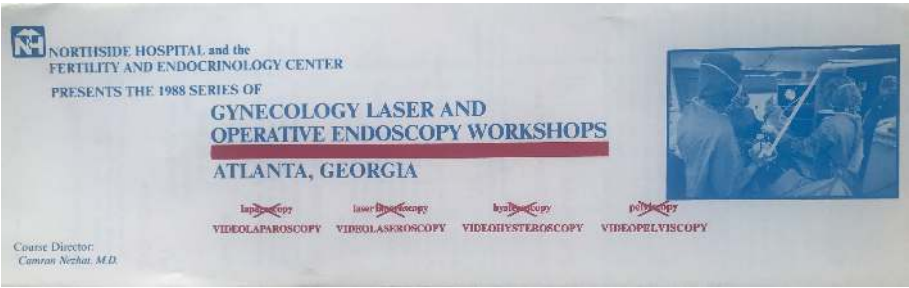


Figure 1.13 Brochure from one of the first workshops on MIS (video laparoscopy) directed by Camran Nezhat in 1988. He started teaching MIS in 1982.

It is noteworthy that the majority of ASRM members, formerly known as the American Fertility Society, were also among the earliest to embrace MIS. The first MIS fellowship was established by the Society of Reproductive Surgeons (SRS) of ASRM, with Dr. Ceana Nezhat as its inaugural fellow, under the guidance of Dr. Camran Nezhat in Atlanta, Georgia. Later, this fellowship was jointly conducted by ASRM and AAGL before eventually separating to establish their own fellowships. Additionally, numerous prominent international physicians and surgeons visited during this time, including Drs. Evo Brosens, Jacques Donnez, Bruno Vanderhaul, Maurice Bruhat, Gerard Mage, Jean Luc Pouley, Michelle Canis, Arnuald Wattiez, Ray Gary, Errico Zuppi, Marcelo Ceccaroni, Maurizio Rosati, George Hillaris, Cihat Unlo, and many others from around the world.

Attendees who saw Nezhat perform these advanced operations video laparoscopically walked away forever awakened to the new horizon. As word spread of a new surgical wunderkind, the early 1980s became a blur of nonstop travel, as Nezhat was invited to operate or present at countless medical society meetings around the world, including at the American Association of Gynecologic Laparoscopists 14th Annual Meeting, November 19–23, 1985, the American College of Obstetricians and Gynecologists in Washington, D.C., May 1985, the World Congress of Gynecology and Obstetrics in Berlin, West Germany, September 15–20, 1985, and the American Fertility Society's (now ASRM) 41st Annual Meeting, September 28–October 2, 1985, to name just some of the earliest.

Barbara Page, Nataliya Vang, and Angie Tsuei

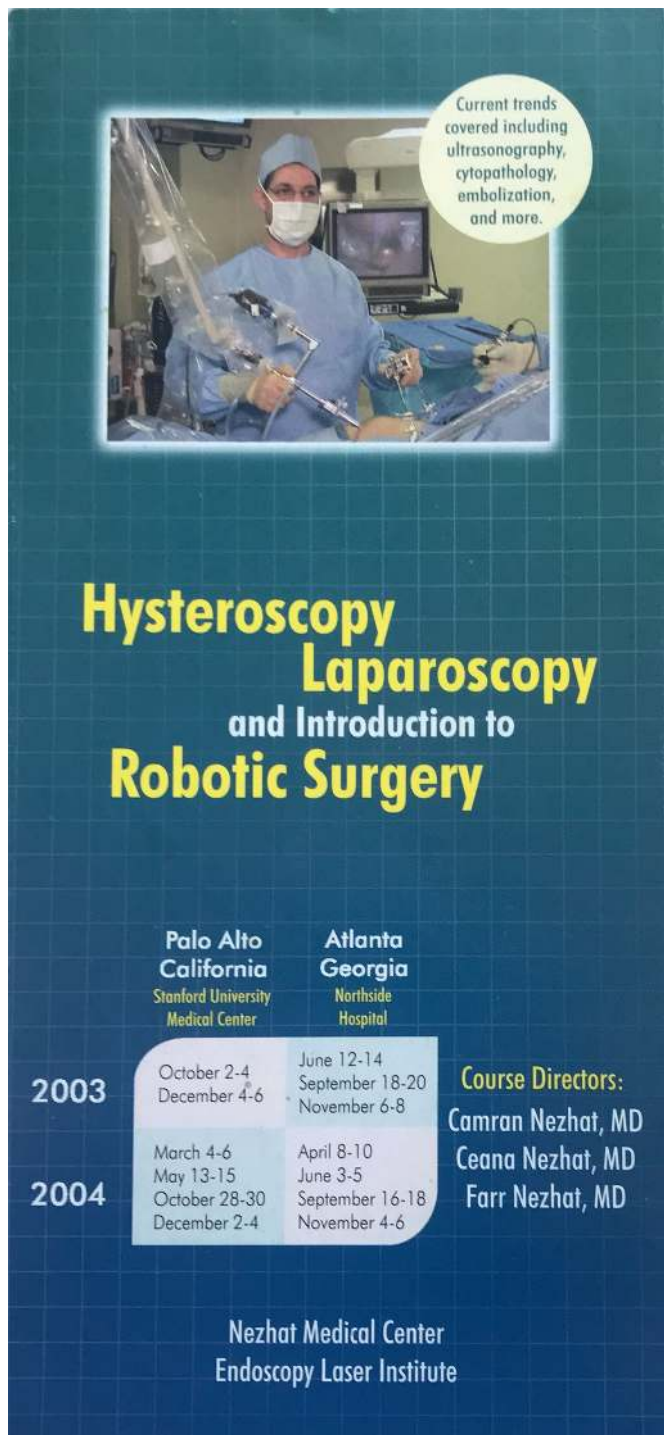


Figure 1.14 Brochure for a course on Minimally Invasive and Robotic Surgery taught by Camran Nezhat and his brothers in Northside Hospital (Atlanta, GA) and Stanford University (Palo Alto, CA) in 2003 and 2004. This was one of the first robotic surgery courses ever offered.

Still, publications continued to be significantly delayed due to repeat rejections by the editorial boards of academic medical journals [46,52–76] (Figure 1.15). Eventually, though, Nezhat's video laparoscopic treatment of extensive endometriosis was finally accepted for presentation and publication in 1985 and 1986, respectively.[3,16,19,28,77] As for some of the more



Figure 1.15 Nezhat just a few years later: notice how much smaller the video camera is here, compared to the one pictured in Figure 1.11. After industry realized that video laparoscopy not only had a future, but would be the future of surgery, they began producing smaller, safer, customized cameras made specifically with video laparoscopy in mind.

controversial surgeries, such as those involving advanced-stage ovarian cancer, there would be several year-long delays before these would gain acceptance for publication.

Eventually, the lay press picked up on these dramatic technological advancements in surgery, with *Atlanta* magazine featuring Nezhat on its cover in 1984, followed by national coverage in *Time* magazine in the April 28, 1986, issue, and in *Newsweek* magazine in the October 13, 1986, issue [78,79] (Figures 1.16 and 1.17).

Indeed, it seemed as if the public and the press couldn't get enough of these fantastical, sci-fi surgery stories: videos and lasers and long metal sticks siphoning organs out of small holes, patients up and about in a day, all patched up with Band-Aids instead of sutures. Of course, the reality was not that simple. There was a lot of work to be done, namely perfecting the instrumentation, refining the procedures, and, most importantly, gathering sufficient clinical evidence to prove that this decidedly more difficult technique with a steep learning curve was providing benefits to patients that were more than just marginally better than traditional surgical techniques. But calls for temperance couldn't stop the floodgates from bursting wide open in what we would recognize today as a viral moment. Nezhat's phone began ringing off the hook with hundreds of requests by surgeons, patients, and the media to visit his OR or receive one of his videotapes so that they could confirm with their own eyes that these reports were real. Eventually, Semm and Nezhat were invited to debate the merits of traditional laparoscopy, which Semm called pelviscopy, versus video laparoscopy, in 1988 at the 3rd European Congress on Hysteroscopy and Endoscopic Surgery in Amsterdam, the Netherlands, marking a watershed moment where the tipping point away from analog and toward modern-day digital MIS was occurring right before our eyes. Dr. William Saye was another early visitor to Nezhat's operating room. Later, Saye became renowned for pioneering the first video laparoscopic cholecystectomies in the US in 1988 and 1989, leading his team consisting of Drs. McKernan, Reddick, and Olsen.