JOURNAL OF ENDOUROLOGY
Volume 18, Number 7, September 2004




# Epochs in Endourology

# Laparoscopic Nephrectomy: Remembrances

RALPH V. CLAYMAN, M.D.

THE HISTORY OF SURGICAL PROGRESS is marked by a succession of disruptive technologies, events after which "nothing is ever the same again." Whether Morton's ether or Bovie's electrosurgical generator, the event is definitive and the effect widespread. While in some instances, one name is associated with the alteration, in most cases, multiple people of different disciplines have come together to create the quantum leap; thus, Morton had his Warren, while Bovie had his Cushing. What is clear is that one person working in one discipline is rarely, if ever, sufficient to satisfy the critical mass necessary to achieve a technological tipping point.

Accordingly, in surgery from 1800 to 1950, the disruptive new technologies were the development of general anesthesia, analgesics, and antibiotics. Each of these major developments enabled surgeons to pursue their craft, although none of these advances enabled them to perfect their craft. Indeed, it was not until the latter half of the 19th Century that the development of endoscopy really began to take hold with the advent of Nitze's cystoscope in 1877. This marked the true beginning of a new disruptive technology: endoscopy.

Up until this point, while Bozzini's Lichtleiter in 1804 was a seminal event in endoscopic history, from a practical standpoint, it was the development of a reliable light source that could be transported deep into the body that really brought endoscopy beyond the limits of the pharynx. This was the inception of endoscopy of an intraluminal nature, allowing the physician to view the inside of the urethra, bladder, larynx, and other hollow organs serviced by a natural cell-lined lumen.

For endoscopy to advance from luminal to laparoscopic required multiple individuals from different disciplines to come together.[1] In the 1800s, the centers of endoscopic development were located in Germany and Austria. In 1870, Simons of Bonn reported the effects of pumping air into the animal abdomen. He found that the air itself resulted in no inflammation. This report was followed in 1877 by Wegner of Berlin, who corroborated Simons' studies by again demonstrating the safety of putting air into the animal abdomen; he measured the absorption of myriad substances, including various gases, across the peritoneal membrane. In 1882, von Mosetit-Moorhof of Vienna purposely injected air into the abdomen in order to create a pneumoperitoneum to treat tubercular peritonitis in a 4-year-old child. This treatment was successful.

However, it is a large leap from putting air into the abdomen to actually looking into the abdomen. To see would require an endoscope. In 1877, Nitze moved from Germany to Vienna to work with Leiter, an instrument maker. It was Leiter, in 1881, who convinced Billroth, chief of surgery in Vienna, of the potential value of the endoscope. Billroth assigned his resident, Mikulicz, to harness Nitze and Leiter's skills in order to develop a gastroscope. Eight years later, in 1890, Georg Kelling came to Vienna to work with Mikulicz. Kelling's major interest was in determining stomach volume through insufflation. Eleven years later, in 1901, Kelling, in an attempt to control intra-abdominal gastrointestinal bleeding, proceeded to instill room air into a dog's abdomen to a pressure of 50 to 100 mm Hg, creating what he termed a "Lufttamponade." Out of curiosity with regard to the effect of the Lufttamponade on the intra-abdominal viscera, he then introduced Nitze's cystoscope, noting that the organs had become rather pale and gray.

The implications of Kelling's bench work languished until 1910, when Hans Christian Jacobius, a Swedish internist, brought laparoscopy to the bedside; he performed diagnostic laparoscopy with room air in 15 patients with ascites and in 2 patients without ascites. Again, the endoscope of the realm, Nitze's, was what was used. However, after this initial 40 years of development (1870–1910), laparoscopic advancement came to a halt. For the next 70 years, laparoscopy remained merely a diagnostic technique used largely by gastroenterologists. Indeed, the foremost proponents of laparoscopy, Heinz Kalk of Germany and John Ruddock of the United States, concurred that "laparoscopy will always remain predominantly a diagnostic method."[1]

It took nearly half a century for this monolithic progress-numbing pronouncement to begin to crumble, and crumble it did, largely at the hands of Kurt Semm. It was the genius of Semm, a Berlin-trained gynecologist, that led to the production of a safe insufflator and the development of techniques for extracorporeal and, later, intracorporeal suturing. In 1983, Semm performed the world's first ***therapeutic*** general surgical laparoscopic procedure by completing an appendectomy. He was soundly criticized and berated: it would take another 5 years for Semm's genius to be appreciated. In 1985, Muhe in Germany performed the first laparoscopic cholecystectomy; he shared the fate of Semm, namely, collegial criticism and os-

Department of Urology, University of California, Irvine, Orange, California.

tracism. Two and three years later, Moray in France and McKernan and Saye in the United States, respectively, corroborated Muhe's laparoscopic cholecystectomy. Today, the only question is why did it take nearly 70 years for laparoscopy to move into the therapeutic realm? We remain indebted to both Semm and Muhe for their vision and their courage.

Urology and urologists have always been at the forefront of minimally invasive surgery. For more than 100 years, our specialty has effectively blended open and endoscopic surgery. By 1988, when interest in laparoscopic cholecystectomy began to take a firm grip on American surgery, I had already been 4 years at Washington University promoting and practicing the new subspecialty of endourology, which I had learned during my residency and early postgraduate years from its originators, Arthur D. Smith and his radiology and urology colleagues at the University of Minnesota (Kurt Amplatz, Wilfrido R. Castaneda, Robert Miller, Paul H. Lange, and Elwin E. Fraley). Prior to going to Washington University in 1984, I had completed an American Foundation of Urologic Disease scholarship at The University of Texas Southwestern School of Medicine in Dallas. While working in the laboratories of the gastroenterologist, John Dietschy, studying cholesterol metabolism in renal-cell cancer, I was able to pursue percutaneous entry into the gallbladder with the idea of using this as a means for stone evacuation followed by sclerotherapy as a new less-invasive therapy for cholelithiasis.

Given my interest in less-invasive surgery, I was aware of laparoscopy because of the work of Cortesi with regard to the search for the cryptorchid testicle that was reported in 1976. Indeed, at the first Frontiers of Endourology course, organized at Washington University in 1985, a demonstration of laparoscopic surgery was provided for the course participants by Dr. Gerald Jordan. Subsequently, I became the recipient of an entire set of laparoscopic equipment through the generosity of Karl Storz, Inc., via Cynthia Drake. However, this set of instruments remained in my office, unused, literally for 2 years, awaiting a potential adult application. In 1988, Howard Winfield, my very first fellow in endourology (1984–1985), revisited Washington University as faculty for the annual Frontiers of Endourology course and proceeded with one of his residents

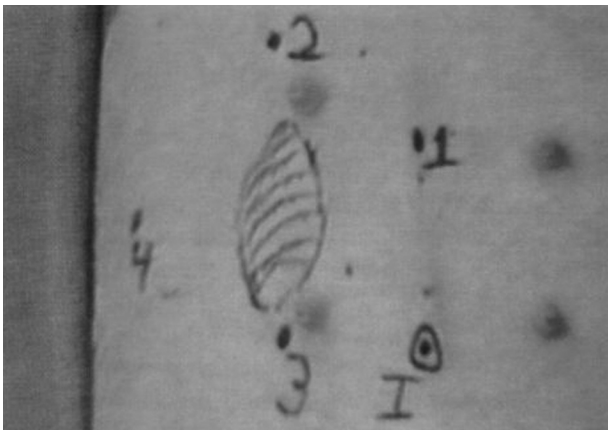


**FIG. 1.** Port site layout on porcine abdomen. The goal was to surround kidney (hatched area) with laparoscopic ports. (Reprinted from reference 3.)

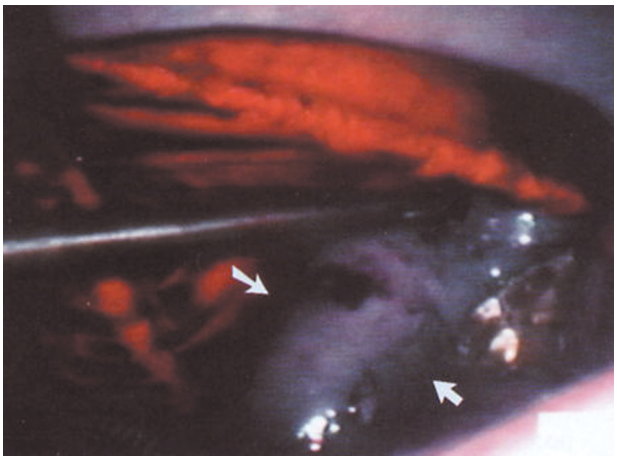

**FIG. 2.** Dissected kidney (arrows) has been manipulated into original Patagonia sack. (Reprinted from reference 3.)

to teach me the rudiments of laparoscopy. Shortly thereafter, laparoscopic pelvic lymph node dissection was first performed by Schuessler and Vancaille in San Antonio; Howard Winfield rapidly picked up the technique and began a series of highly successful courses to teach laparoscopy to hundreds of urologists who attended his courses at the University of Iowa.[2]

Accordingly, it was fortuitous in 1988, with the fuse to the "cholecystectomy craze" just lit, that Samuel A. Wells, Jr., Chairman of Surgery at Washington University, invited me to a meeting with a newly hired young general surgeon, Nathaniel J. Soper. Dr. Wells knew of my earlier work on percutaneous entry into the gallbladder, the two of us having discussed this on my arrival at Washington University, and of my general interest in minimally invasive surgery. Also, at that time, he knew that there was a very active endourology animal laboratory and that I had a full set of laparoscopic equipment. Accordingly, in 1989, Nat Soper, his fellow, J. Barteau, and I began to do some laparoscopic work in the animal laboratories. The primary motivating factor in this association was the fact that at that time, most laparoscopic cholecystectomies were being done using a laser, and it was our aim to see if indeed the same procedure could be done much less expensively using readily available electrosurgical equipment. The experience with Dr. Soper provided me with significant laparoscopic exposure.

After completing the gallbladder project, I teamed up with Louis R. Kavoussi, who, following his residency in urology at Washington University, accepted a faculty position. With Lou, I began to wonder about removing the kidney laparoscopically, as in all of the porcine gallbladder work, the kidney was always readily visible. Indeed, in the pig, it appeared to be as accessible as the gallbladder. This is because in the pig, the colonic attachments lie medial to the kidney rather than lateral to it, as in the human; a confounding factor that somehow had eluded our attention until we were later confronted with our first clinical case. Together, Lou, Nat, and I began to pursue the possibility of removing the porcine kidney laparoscopically. After many late nights in the animal laboratory with Stephenie Long (laboratory assistant), Stephen Dierks (urology resident), as well as Shimon Meretyk (endourology fellow), we found that we were able to secure the ureter as well as the renal artery and

renal vein using the 9-mm clip applier that had been developed by U.S. Surgical for securing the cystic duct and blood vessels to the gallbladder (Fig. 1).[3] However, a major drawback of the technique, we believed, was the fact that at the end of the procedure, an incision needed to be made in order to remove the kidney. As such, Lou and I began to toy with the idea of entrapping the kidney in order to remove it and subsequently found that this could be done using a sack with a drawstring that actually came with a pair of Patagonia running shorts that I had purchased (Fig. 2). However, even with the organ entrapped, an incision had to be made in order to remove the organ. To avoid this, the concept of morcellation was brought up so that the entire procedure could be done through a 12-mm port. While mechanical morcellation with forceps was an obvious solution, we were looking for something more elegant and quicker. Initially, we tried a set of Karl Storz orthopedic shavers; however, these were too slow for the job at hand.

At the American Urological Association Meeting in New Orleans in May 1990, I had the good fortune to discuss laparoscopic nephrectomy with Mr. Fred Roemer of Cook Urological Inc. Fred and I had an association going back to the initial days of endourology and the University of Minnesota courses that began in 1982. His encyclopedic knowledge of engineering in urology and of all of the products in the pipeline at Cook led to his sharing with me that, indeed, Cook Ob-GYN had developed an effective morcellator/tissue evacuator. However, it relied on suction in order to remove the tissue and thus was not practical for use in a laparoscopic environment. However, because our specimen was entrapped in a sack, suction to evacuate the tissue would not present a problem, as it should have no impact on the pneumoperitoneum. Soon thereafter, our endourology team at Washington University made seven attempts at a porcine laparoscopic nephrectomy, succeeding in six cases, with an average operative time of 2.8 hours.[2] At each step along the way, a dedicated group of engineers from Cook Urological worked with us, not only long distance, but in the laboratory itself. Fred Roemer, Paul Thomsom, and Ed Pingleton made several round trips from Spencer, Indiana, to St. Louis during these laboratory studies; each time they returned, the morcellator and the entrapment sack had both been markedly improved.

Shortly after this initial bench work was completed, I saw an 85-year-old woman with a 3-cm right mid-renal tumor who I thought might be a good candidate for this procedure. As she was thin and had no major health problems, the laparoscopic approach seemed possible in her case. She had no family, only a close friend. Lengthy discussions with the patient ensued. Amazingly to me, the success of the proposed procedure was never in doubt in her mind; all attempts on my part to disabuse her of this notion were to no avail. In frustration and out of concern, I had her closest friend come to the office to explain what we were going to attempt to do and the novelty and potential risk of the planned laparoscopic procedure. In addition, after a late-night discussion with William Catalona, I also sought approval from the Washington University Institutional Review Board. The patient, her friend, and the IRB all agreed to allow our team to proceed.

On the morning of June 25, 1990, the patient went to interventional radiology; her right main renal artery was embolized by Michael Darcy, our interventional radiologist, so that the renal vein could be "taken" as soon as it was dissected. The patient then came to the operative suite for the laparoscopic procedure by Lou Kavoussi, Nat Soper, and me; Steve Dierks, Stephenie Long, and Shimon Meretyk were also in attendance. Anesthesia was given by Terri Monk, a truly gifted anesthesiologist I entrusted with the responsibility of telling us when to convert; I knew that at the first sign of any problems from a prolonged pneumoperitoneum, she would advise us to "open." Cystoscopy was performed, and an external ureteral stent was placed; I wanted to make sure we could identify the ureter rapidly. Then, after obtaining a transumbilical Veress needle pneumoperitoneum, five ports were placed. Given that the only means of securing the vessels was the 9-mm clip applier, the dissection was done fairly high up in the hilum; five sets of vessels were individually secured with the clip applier and divided. The kidney was entrapped in a prototype Cook Urological entrapment sack, and morcellation/evacuation with the Cook morcellator was completed; the latter required exactly 7 minutes. The total operating room time was 6.8 hours.

During the procedure, there was profound oliguria. Fortunately, postoperatively, the oliguria resolved within a few hours. However, throughout the procedure, the patient had been receiving fluids as though we were working through an open wound to try to increase her urine output. She became markedly fluid overloaded, developing a picture of congestive heart failure and a significant drop in her hemoglobin. Vigorous diuresis and a 1-unit blood transfusion overcame both problems. She required 3 mg of morphine sulfate throughout her hospital stay. She was discharged on postoperative day 6, and the pathology report returned oncocytoma.

In 1990, the full case report was submitted as an article to the *New England Journal of Medicine*. I received a phone call informing me that the article was not acceptable but that perhaps a letter to the editor would be publishable. Interestingly, the only question asked of me by the person from the Editorial Board was how many times we had failed clinically before succeeding. Perhaps this was for me the most telling moment, as it clearly justified all of the laboratory work that we had done for the months preceeding the clinical trial. I was delighted to reply that because of the diligent work that was done in the laboratory before taking this procedure to the bedside, we had never failed. In 1991, a letter to the editor was published in the *New England Journal of Medicine* announcing the first clinical

**FIG. 3.** Early days of laparoscopic nephrectomy at Washington University, circa 1991. From left to right: P.S. Chandhoke, Louis Kavoussi, David Albala, R.S. Figenshau, and R.V. Clayman.

laparoscopic nephrectomy with morcellation/evacuation.[4] The full formal report was not published until August 1991, in the *Journal of Urology*.[5]

Of note is that the individuals responsible for this "laparoscopic first" were urologists, a general surgeon, an anesthesiologist (Terri Monk), an interventional radiologist (Mike Darcy), and a group of three engineers (Fred Roemer, Ed Pingleton, and Paul Thomson of Cook). Again, a disruptive technology had been birthed by multiple individuals from various disciplines, all committed to a common goal.

After the initial laparoscopic nephrectomy in June of 1990, it was just a matter of time before many other renal procedures would be done laparoscopically. Indeed, the team at Washington University proceeded to perform the world's first retroperitoneal laparoscopic nephrectomy in December 1990, which was subsequently followed by the initial laparoscopic nephroureterectomy (Fig. 3).[6,7] Following this, the first partial nephrectomy went from bench to bedside in a matter of less than a year. Seminal work done by Elspeth M. McDougall on laparoscopic partial nephrectomy in the laboratory was translated into a clinical reality when Howard Winfield and his team at the University of Iowa performed the first laparoscopic partial nephrectomy in 1993.[8,9] Interest in donor nephrectomy began at Washington University, and indeed, it was Inderbir S. Gill, a research fellow, along with Joseph Carbone, a urology resident, who showed the feasibility of this approach in 1994 at the bench.[10] Subsequently, Lloyd Ratner and Lou Kavoussi, both with ties to Washington University, came together at Johns Hopkins, where they performed the first laparoscopic donor nephrectomy in 1995.[11] At the same time, other laparoscopic ablative renal firsts were being described: cyst excision, caliceal diverticulectomy, pyelolithotomy, and renal biopsy.[12–16]

As laparoscopy became more widely accepted, instrumentation improved. In this regard, the ability to suture laparoscopically became more and more feasible, and laparoscopic reconstructive renal procedures soon followed. In 1993, our group at Washington University reported the first case of laparoscopic nephropexy.[17] In the same year, Schuessler and associates proceeded to perform the first laparoscopic pyeloplasty.[18] Between 1990 and 1993, more than 90% of all types of "open" renal surgical procedures had been performed laparoscopically. All that remained were a few of the more rare renal procedures such as ureteral calicostomy and anatrophic nephrolithotomy; both of these have since been done by Inderbir Gill and his team at the Cleveland Clinic.[19]

Today, laparoscopic renal surgery is an entity unto itself. Indeed, the vast majority of nephrectomies for benign and malignant disease worldwide are now being performed laparoscopically. In addition, at most major medical centers, laparoscopic renal surgery is being used for donor nephrectomies; the end result has been a marked increase in the donor nephrectomy population. Furthermore, laparoscopic renal surgery has been extended now to partial nephrectomy as well as wedge excision to treat small renal masses. In the realm of reconstructive surgery, laparoscopy is now being performed in many centers for pyeloplasty and complicated partial nephrectomies. Indeed, at several large medical centers, the majority of renal surgery is now performed laparoscopically. In a mere 14 years, yet another disruptive technology has come to the fore, replacing the pain and disfigurement common to open surgery with a kinder, gentler solution, both efficient and effective.

In the final analysis, one cannot be complacent with the progress that has been made, for surely, where we are is merely another step along the path of surgical progress. The fun is in the journey and the tremendously creative minds and appreciative patients that one encounters along the way.

**Disclaimer:** All of the foregoing text is largely my personal remembrances. It would be impossible to recognize everyone who has participated in the progress of laparoscopic renal surgery. I apologize to any individuals I have overlooked as a result of my perhaps overindulgent bias or frank lack of knowledge. In truth, this advance has been an accomplishment of the many.

## REFERENCES


1. Litynski GS. Highlights in the History of Laparoscopy. Frankfurt: Barbara Bernert Verlag, 1996, p 367.
2. Griffith DP, Schuessler WW, Vancaille TH. Laparoscopic lymphadenectomy: A low morbidity alternative for staging pelvic malignancies [abstract]. J Endourol 1990;4(suppl):S84.
3. Clayman RV, Kavoussi LR, Long SR, Dierks SM, Meretyk S, Soper NJ. Laparoscopic nephrectomy: Initial report of pelviscopic organ ablation in the pig. J Endourol 1990;4:247–252.
4. Clayman RV, Kavoussi LR, Soper NJ, Dierks SM, Meretyk S, Darcy MD, Long SR, Roemer FD, Pingleton ED, Thomson PG. Laparoscopic nephrectomy [letter]. N Engl J Med 1991;324:-1370–1372.
5. Clayman RV, Kavoussi LR, Soper NJ, Dierks SM, Meretyk S, Darcy MD, Roemer FD, Pingleton ED, Thomson PG, Long SR. Laparoscopic nephrectomy: Initial case report. J Urol 1991;146: 278–282.
6. Kerbl K, Figenshau RS, Clayman RV, Chandhoke PS, Kavoussi LR, Albala DM, Stone AM. Retroperitoneal laparoscopic nephrectomy: Laboratory and clinical experience. J Endourol 1993;7:-23–26.
7. Clayman RV, Kavoussi LR, Figenshau RS, Chandhoke PS, Albala DM. Laparoscopic nephroureterectomy: Initial clinical case report. J Laparoendosc Surg 1991;1:343–349.
8. McDougall EM, Clayman RV, Chandhoke PJ, Kerbl K, Stone AM, Wick MR, Hicks M, Figenshau RS. Laparoscopic partial nephrectomy in the pig model. J Urol 1993;149:1633–1636.
9. Winfield HN, Donovan JF, Godet AS, Clayman RV. Laparoscopic partial nephrectomy: Initial case report for benign disease. J Endourol 1993;7:521–526.
10. Gill IS, Carbone JM, Clayman RV, Fadden PA, Stone AM, Lucas BA, McRoberts JW. Laparoscopic live-donor nephrectomy. J Endourol 1994;8:143–148.
11. Ratner LE, Ciseck LJ, Moore RG, Cigarroa FG, Kaufman HS, Kavoussi LR. Laparoscopic live donor nephrectomy. Transplantation 1995;60:1047.
12. Healy DE, Newman RC, Cohen MS, Mars DR. Laparoscopically assisted percutaneous renal biopsy. J Urol 1993;150:1218–1221.
13. Hulbert JC. Laparoscopic management of renal cystic disease. Semin Urol 1992;10:239–241.
14. Gaur DD, Agarwal DK, Purohit KC, Darshane AS. Retroperitoneal laparoscopic pyelolithotomy. J Urol 1994;151:927–999.
15. Jordan GH, McCammon KA, Robey EL. Laparoscopic pyelolithotomy. Urology 1997;49:131–134.
16. Brunet P, Meria P, Mahe P, Danjou P. Laparoscopically-assisted percutaneous nephrolithotomy for the treatment of anterior calyceal diverticula. BJU Int 2000;86:1088–1089.
17. Urban DA, Clayman RV, Kerbl K, Figenshau RS, McDougall EM. Laparoscopic nephropexy for symptomatic nephroptosis: A case report. J Endourol 1993;7:27–30.

18. Schuessler WW, Grune MT, Tecuanhuey LV, Preminger GM. Laparoscopic dismembered pyeloplasty. J Urol 1993;150:1795–1799.
19. Kaouk JH, Gill IS, Desai MM, Banks KL, Raja SS, Skacel M, Sung GT. Laparoscopic anatrophic nephrolithotomy: Feasibility study in a chronic porcine model. J Urol 2003;169:691–696.

Address reprint requests to:
*Ralph V. Clayman, M.D.*
*Department of Urology*
*University of California, Irvine*
*101 The City Drive*
*Bldg. 55. (Room 304)*
*Orange, CA 92868-3298*

*E-mail:* rclayman@uci.edu

## EDITORIAL COMMENT

Often, a momentous event inexorably alters the course of history, and humanity is blessed forever. Laparoscopic nephrectomy, developed by Clayman and associates, is such a milestone that made the phoenix of therapeutic laparoscopy rise from the ashes of dormancy and led us to the joyous shores of continued laparoscopic innovations. In his impeccable literary design, Clayman pays homage to the pioneers and narrates the seminal events leading to the performance of the first laparoscopic nephrectomy. This epistle is a treasure for our posterity.

*Sakti Das, M.D.*
*University of California-Davis*
*Sacramento, California*