Application of emerging technologies to urologic oncology
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CHAPTER 1

INTRODUCTION

Interest in emerging technologies continues to rise at an unprecedented rate in the overall history of surgery and more specifically urology. With the introduction of laparoscopy and more recently robotics, this interest is currently evident in the urologic community. The wide range and availability of information has led the patient population to demand the use of emerging technologies from the urologist.

Laparoscopic surgery owes much of its history to the development of endoscopic technique in the beginning of the nineteenth century. In 1805, Phillip Bozzini, a German physician, developed a candlelight held funnel to examine body orifices. It is considered as the first endoscopic instrument, but was proven cumbersome for the operator and painful for the patient. In 1826, Pierre Segalas from France refined the urethroscope adding an introduction cannula and mirrors for light reflection [1,2]. In 1867, Julius Bruck, a dentist of Breslau, had the bright idea to bring the light into the body cavity using a platinum wire loop heated by an electric current [3], and Max Nitze from Germany successfully applied this kind of illumination source to his cystoscope in the late 1800s. The heat generated by this lamp was a major limitation until 1898, when Charles Preston provided a bright light produced with low amperage current [4]. This became the standard light source for endoscopy until an adequate external system of light delivery was developed fifty years later.

In 1870, Simons from Bonn, introduced the concept of distending the peritoneal cavity with air to aid in visual inspection after his preliminary work in the animal model. In 1882, George Kelling from Germany had the pioneering idea of employing a cystoscope for the inspection of abdominal viscera. In 1901, he performed a so-called "coelioscopy" on a dog. Kelling’s advanced work was particularly notable for the use of a separate needle to produce the pneumoperitoneum.

In 1920, Orndoff devised a trocar with a pyramidal point and an automatic cannula valve to prevent the escape of gas from the pneumoperitoneum [5]. In 1924, Zollikofer from Switzerland introduced the use of CO₂ for insufflation and observed its ease of absorption. In 1938, Veress from Hungary further refined the automatic needle initially used for the creation of pneumothorax in the treatment of tuberculosis [6]. The Veress needle is now routinely used to create pneumoperitoneum. The development of the open trocar technique of Hasson expanded the indications for laparoscopy including patients with a history of prior laparotomy and adhesions, considered a contraindication to laparoscopy so far [7, 8].
Kurt Semm, a German gynecologist, who developed many laparoscopic operative techniques and instruments including intracorporeal suturing techniques, a controlled insufflation apparatus, and safe endocautery devices, performed the first laparoscopic appendectomy, which was a considerable task given the limited instrumentation [9].

Meanwhile, laparoscopy made its initial forays into the interventional realm. Due to advances and modifications in high frequency unipolar electrocautery, in 1933 Fervers from Germany, burned abdominal adhesions and performed an excisional biopsy [10].

The use of high frequency monopolar cautery within the abdominal cavity had been limited by serious bowel injury. The electrical shielding of instruments and current reduction were introduced to obviate these problems.

In 1985, Muhe from Germany performed the first laparoscopic cholecystectomy and was widely and harshly criticized like Semm after performing the first laparoscopic appendectomy. The first clinical series of laparoscopic cholecystectomy were performed by Francois Dubois in France in 1988, who documented the capability of laparoscopic cholecystectomy to duplicate open surgical principles [11].

Laparoscopy in urology paralleled, to a large extent, the changes in general surgery. Up to the late 1980s, urologic laparoscopy had limited applications. In 1976, Cortesi reported laparoscopic abdominal exploration in an 18 year old patient with bilateral abdominal testes [12]. However, apart from its use in the pediatric population for cryptorchidism, urologic laparoscopy lacked a broad application when compared to the large population of patients with cholelithiasis treated laparoscopically by general surgeons. In fact, in many urologic procedures the benefits of laparoscopy were initially outweighed by the technically challenging anatomy that greatly limited access and compromised control. Varicocelectomy and bladder neck suspension were deemed feasible, but showed little benefit over open surgery.

Renal procedures are the main target for urologic laparoscopic organ resection. Laparoscopic nephrectomy in a porcine model was first attempted via a retroperitoneal approach by Weinberg and Smith in 1988 [13]. In 1991, Clayman et al performed the first clinical laparoscopic nephrectomy [14-16]. With increasing skills and experience, such procedures heralded a new era in laparoscopic urology that began to challenge and compete with conventional open surgery. However, many technical refinements were necessary to make laparoscopy an appealing alternative to open surgery.

As a result, more challenging laparoscopic renal procedures were progressively attempted and executed. Winfield et al performed the first laparoscopic partial nephrectomy in 1993. Subsequent series of laparoscopic partial nephrectomy (LPN) reported by many authors showed cancer control similar to open nephron-sparing procedures.
The next urologic milestone in laparoscopic organ resection was the management of prostate and bladder diseases. Laparoscopic radical prostatectomy (LRP) was innovated in 2000 in France by Guillonneau and Abbou [17-18]. Latest series of LRP showed outcomes similar to those of the open approach. Nevertheless, laparoscopic technology and experience on LRP, and their acceptance, continue to evolve.

Laparoscopy has been applied also to the technically demanding area of cystectomy. In 2000, Gill et al. reported their initial experience with laparoscopic radical cystectomy with bilateral pelvic lymphadenectomy, and ileal conduit urinary diversion in patients with muscle-invasive bladder cancer [19]. The ability to complete this procedure intracorporeally required a high level of reconstruction that has also been applied to other areas in urology.

The development of a robotic platform (da Vinci® Surgical System - Intuitive Surgical, Inc.) made the learning of intracorporeal suturing easier by offering a 3D vision and articulated instruments.

It is becoming increasingly evident that laparoscopy has the potential to duplicate the principles of open urologic surgery for the management of several uro-oncological pathologies. However, while the feasibility of many laparoscopic procedures was proved, these techniques still need to be refined, their safety evaluated and long-term oncological and functional outcomes are necessary before these procedures are validated as an alternative to the open approach.

As such, herein, I present a series of new surgical technique validations and urologic oncological outcomes analyses. These technologies include laparoscopy, robotics, and more recently, NOTES (Natural Orifice Translumenal Endoscopic Surgery).

REFERENCES