Robotic urological surgery is one of the most significant urological developments in recent years. It allows for greater precision than laparoscopic methods while retaining quicker recovery time and reduced morbidity over classical open surgical techniques. For children, where the room for error is already reduced because of smaller anatomy, it takes on even more importance for urologists. As a result, robotic surgery is rightly considered one of the most exciting contemporary developments in pediatric urology.

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- All videos are referenced in the text where you see this logo 📀

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Dedication

To my late grandfather, Mr. Hanmantu Gundeti, for my rich inheritance of humanity. My parents, Mr. Saheb Hanmantu and Mrs. Bhudevi Saheb Gundeti, who showed me that the path of success comes only through the virtue of hard work.

To Laltia, my better half, for allowing me to pursue my dreams of becoming a pediatric urosurgeon. Madhav and Manohar, my brothers for their continued support on this long journey. My wonderful kids, Anjali, Amol, and Apoorva for their love.

To all my family members, teachers, and friends for their continuous encouragement. To all my patients and their families for giving me the opportunity to serve them.

Mohan Saheb Gundeti
July 4th, 2011
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Forewords

One hundred and fifty years ago urology was called genitourinary surgery. Two thousand five hundred years ago, as the single exclusion for a medical practice in the Hippocratic Oath, the practitioners “of that art” were lithotomists. Bladder calculus was the original defining problem, plaguing mankind from his beginning, and any surgical relief required not only an intrepid lithotomist, but also some means of technology albeit primitive back then.

Urology has evolved since those early days and has remained heavily contingent on technology. Urologists are typically the creators or first adapters of new instruments or approaches to clinical problems. Urethral catheters and sounds, lithotrites, cystoscopes, transurethral electroscopy, open prostatectomy, retrograde pyelography, transurethral prostatectomy, genitourinary reconstruction, percutaneous nephrostomy, ureteroscopic stone extraction or ablation, extracorporal shock wave lithotripsy, prostate/renal cryoablation, laparoscopic nephrectomy, robotic radical prostatectomy, and transcutaneous histotripsy are sequential examples which prove how human imagination has become urological reality.

The idea of the automaton figured early in human imagination, recorded in ancient China and later in the works of Aristotle, Homer, Al-Jazari, and Leonardo da Vinci. The actual term “robot”, as many know, came from Karel Čapek, a Czech author, in his play R.U.R. (Rossum’s Universal Robots) which I recall reading in high school. The concept was riveting to me, and somewhat subversive relative to modern society as seen by a teenager. Čapek credited his brother, Josef, with the word robot deriving it from a Czech term for servitude. It didn’t take long for the idea to make the movies, and Fritz Lang’s classic “Metropolis” in 1927 still enjoys viewings among serious filmgoers. Isaac Asimov performed the great synthesis of his neologism “robotics” and an ethical framework for the fictional technology in his Three Laws of Robotics. This happened definitively in his short story “Runaround” in 1942. These are the three laws:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Asimov later added a law he called the “zeroth”: A robot may not harm humanity, or, by inaction, allow humanity to come to harm. What was compelling science fiction has quickly become reality.

Urologists are technocrats of medicine, it is their nature to explore, perfect, and push the limits of new clinical methods and platforms. It was just a matter of time before robotic technology was extended to the world of surgery and urologists, as one might expect, were early adaptors. Mohan Gundeti, a robotic virtuoso, has extended the range to robotic surgery throughout the pediatric urology domain. It is good and appropriate that some of our best surgeons should push the limits of new technologies. Yet we do not expect that the robot will replace unassisted manual surgery across the board for the entire range of pediatric urology. Some procedures will remain preferably undertaken “the old fashioned way” for reasons of simplicity, safety, time, resource availability, and cost. The text that follows by Mohan very nicely shows the range of possibility for pediatric urology in 2011. The
clinical marketplace over the next few years will ascertain the appropriate specific domain of pediatric urological robotics, that is, which procedures and which children are advantaged by the robot. Meanwhile we must remain on the lookout for the next technological tipping point in urologic surgery, for surely something new and even better is waiting for us down the road.

David A. Bloom  
*University of Michigan, Ann Arbor, MI, USA*  
*July 15th, 2011*

I am excited to witness the production of a textbook covering pediatric and reconstructive robotic surgery. For the past 10 years robotic surgery has evolved safely and successfully in adult urologic surgery to cover multiple applications. The arrival of robotics to the pediatric urology specialty is marked by the publication of this work. The chapters in this book superbly cover all aspects of pediatric and reconstructive robotic surgery, giving the reader insight, tips and tricks, and practical knowledge for a novice to start or an expert to expand his robotic surgery practice.

The editor has assembled authors from all over the world, who are experts in this field. The addition of the video is a helpful and unique educational tool, especially for this novel approach to surgery.

I commend the editor and authors for their great work, and am certain that a generation of urologic surgeons will benefit from this book.

*Arieh L. Shalhav*  
*University of Chicago*  
*Chicago, IL, USA*  
*July 15th, 2011*

It is a joy to provide a foreword for this book. The subject is new, exciting and of practical benefit to our patients. The techniques described will replace many forms of conventional surgery in the future. The book provides the reader with a broad synopsis of robotic surgery and in particular its adaption to the pediatric population. There is still much to develop in this area. The chapters are mostly multi-authored, which underwrites a sound clinical aspect to the contents while simultaneously providing a good overview. The book is a complete review of robotic surgery and will be a standard text for clinicians using robotic surgical techniques in the treatment of their patients.

*Patrick G. Duffy*  
*Great Ormond Street Hospital for Children*  
*London, UK*  
*June 22nd, 2011*
Preface

The Evolution and Future of Robotic Surgery in Pediatric Urology

While all physicians probably view their professional experience as being characterized by rapid and evolutionary change, it may be argued that the last 20 years in surgery and urology have seen truly revolutionary changes that represent real paradigm shifts in how we perform our surgical procedures. The advent and emergence of laparoscopy have greatly changed our landscape in urology, and while it has done so less spectacularly in pediatric urology, its impact is nonetheless significant. Having had the privilege of participating in this evolution in pediatric urology from the earliest days of laparoscopy to the emergence of robotic surgery for children, I have had the good fortune to see the challenges, successes, and potential of these new technologies up-close. Three important factors will continue to exert pressure on the pathways of innovation in pediatric urological minimally invasive surgery.

The first is the inherent drive to reduce surgical morbidity in children. Everyone would prefer to inflict less discomfort on a child, yet it is frequently stated that children recover quickly from any incision. Although this is true in a relative sense, it is clear that they suffer from surgical morbidity in their own way. We may not always be able to measure this objectively, but an experienced surgeon can see the impact almost as well as the parent. Our efforts to reduce this impact should not be trivialized by simplistic assertions that an incision does not cause much pain. We need to focus efforts on being able to assess surgical morbidity in children of all ages, and develop means to reduce this using modern technology. At the same time, the importance of enhancing the efficacy of any surgery is also critically important. This is seldom considered in the laparoscopic field, but with robotic technology, there is the real potential for enhanced outcomes due to improved visualization, tissue manipulation, and motion control. This will be difficult to prove objectively, yet must be considered. To enhance outcomes further, we recognize the second important feature on the evolution of pediatric minimally invasive surgery.

The challenge of making instruments child friendly continues from laparoscopy into robotic surgery. None of the current instruments are truly suitable for small children, yet most surgeons using the da Vinci system have made them work. This was similarly the case with early laparoscopy when we were performing nephrectomies with all 10 mm cannulae simply because there was nothing else. The children did fine, but clearly we needed to do better. Robotic technology can improve, although the economic incentives remain limited. Perhaps with widening utilization by other specialties, the potential importance of pediatric surgical practice will become evident. It remains critically important for the pediatric practitioner to be actively engaged in the process of development of these technologies, otherwise they will never be suitable for children and we will remain in the shadows of practice, which is certainly not in the best interests of our patients.

There is a particular attractiveness of robotics for children based on the need for exquisite visualization, delicate motion control, and tremor filtering. The three-dimensionality of the imaging system permits enhanced precision and accuracy. All of these elements have long been considered essential to the satisfactory performance of pediatric reconstructive urology. Although the current instrument is limited in terms of its delicacy, it can and has been...
used effectively for very small children and precise procedures. Given the economic burden of modern robotic systems, many have stated, however, that conventional laparoscopy can be used instead of the robot. Although this is probably true in the context of a practitioner who performs one operation repetitively and can effectively learn the technique and basic skills needed for precise laparoscopic surgery, this is a rarity in pediatric urology. Even in a large and busy referral practice, it is rare that one surgeon can perform enough laparoscopic operations in pediatric urology to develop the proficiency to perform a pyeloplasty with the same precision as can be performed with open surgery or robotically. Even if this were the case, it is unlikely that centers of excellence would ever develop for pyeloplasty. This is a basic and common operation that all pediatric urologists should be able to perform readily. Therefore, technology that can permit the majority of pediatric urologists to offer a minimally invasive alternative to open surgery for pyeloplasty and other such reconstructive procedures would seem attractive. This is what the da Vinci system offers and has been shown to be able to perform. The referral centers will likely develop the more complex procedures and refine the basic ones, but providing access to this type of beneficial technology to a wide population would seem appropriate.

This volume describes the various robotic surgical approaches that have evolved very rapidly using the da Vinci system. It should be evident that there is a robust potential in this technology, yet a note of caution must be heard. We cannot use this technology in the absence of the highest quality of clinical pediatric urology. Using a surgical robot in children does not make an adult urologist a pediatric urologist. Indications for surgery should not yet change until a significant reduction in morbidity is proven. Surgical strategies should not change until efficacy is proven. With these foundations, however, the potential of robotic technologies in pediatric urology and surgical practices are enormous. It is exciting to consider the future horizons of such innovation, particularly when reflecting on how far we have moved in such a short time.

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Acknowledgments

This book is a product of hundreds of professional minds coming together and giving their best to serve mankind.

First, my thanks go to all the authors for their valuable contributions, especially for their efforts within their busy schedules.

To Rob Blundell at Wiley-Blackwell for the concept of producing a dedicated book on this emerging technology in pediatric urology. Thanks also to Michael Bevan, Phil Weston, Gill Whitley and the rest of the team, for their diligent work.

To all my teachers, mentors, friends, colleagues at work in India, London, and Chicago, with thanks for their encouragement and support.

Finally, a thank you to the patients and their families for putting their faith and trust in me and for giving me the wonderful opportunity to serve them.

M.S.G.
History, Training, Instrumentation, and Physiology
The Evolution of Robotic Surgery and Its Clinical Applications

Shyam Sukumar, Mahendra Bhandari, and Mani Menon
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Robotics makes the transition to the Information Age complete by looking at information (the monitor) and manipulating information (hand motions send electronic signals which control the tip of the instruments). It is no longer blood and guts, but it is bits and bytes.

Richard M. Satava [1]

Evolution of surgical access

Minimally invasive surgery in general and robotic surgery in particular have challenged the age-old practice of long or multiple incisions and wider exposure to handle complex surgeries. Studies examining the systemic effect of surgical intervention (including the size and location of incisions) support the beneficial effect of minimally invasive surgery on the biological and immunological level [2,3].

Minimal access

John Wickham, a British urologist, coined the term “minimally invasive surgery” in 1983 [4–6]. A vociferous champion of endoscopic techniques, he classified the history of surgery in three phases, the first being the “brutal and ablative” medieval epoch, followed by the era of improved resuscitation and carefree incisions, and lastly the modern age beginning from the 1960s onwards. The modern age involved small pockets of enlightened surgeons gradually embracing techniques involving minimal access [4].

The possibility of intra-abdominal insufflations and endoscopic visualization (and hence “the laparoscopic concept”) was first reported by G. Kelling, who insinuated a cystoscope trans-abdominally and applied pneumoperitoneum for treating blood loss [7]. Contemporaneously, culdoscopic access was described by D.O. Ott in a pregnant woman [7]. A significant milestone was the application of the Veress needle, initially

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developed for the creation of therapeutic pneumothorax to treat tuberculosis [7].

Kurt Semm further revolutionized the field of laparoscopic surgery by advocating the “keyhole” approach in gynecologic surgery, and controversially performing the first laparoscopic appendectomy. He is to be credited with developing endoscopic hemostatic suturing and, more than anyone else, was singularly influential in designing the range of innovative instruments indispensable for minimal access [8].

Erich Muhe performed the first human laparoscopic cholecystectomy in 1985. The French triumvirate of Mouret, Dubois, and Perissat then standardized and popularized laparoscopic cholecystectomy as a mainstream procedure [9].

The evolution of tools and techniques for port placement has significantly reduced access-related morbidity such as vascular, bowel, and wound site complications and mitigated oncologic complications related to access — the abdominal metastatic seeding of neoplasms [10]. Access for most urologic procedures involves one of three approaches: open (Hasson), closed (using a Veress needle), or optical ports [11]. Optical ports allow direct visualization of the various tissue layers during access. Trocar type has moved from the use of pyramidal and conical trocars to the use of trocars with bladeless tips, which are less traumatic and hence result in favorable wound parameters.

Evolution of vision systems

The single seminal breakthrough which paved the way for state-of-the-art endoscopic surgery was the development of the fiber-optic system. It was indeed a giant leap for surgeons — from the era of working in natural passages under candlelight brightness through incandescent bulb illumination energized by dry cells to bright vision, which could be carried to any body cavity through fiber-optic carriers.

Taking a radical approach to endoscopic clarity and definition, Harold Hopkins (along with Kapany) published a report in Nature in 1954 describing the “fiberscope,” in which light passed through bundles of fine fibers of glass increased the quality of the images. Building on Hopkins’ work, Basil Hirshowitz developed the first clinically useful gastroscope [12]. Hopkins was responsible for another seminal innovation, this time in cystoscopy (his initial assignment being to capture images inside the bladder), with his introduction of the rod lens system. Whereas the traditional endoscope consisted of a tube of air with lenses of glass (as the “objective”) Hopkins’ version consisted of a tube of glass with lenses of air, which greatly increased the amount of light transmitted [12]. Having been denied a conducive commercial response in Britain, Hopkins was fortunate enough to find a collaborator in Karl Storz [12], thereby beginning, arguably, the most important collaboration in the history of endoscopic instrumentation.

Another obstacle with the early systems was that they hampered concerted coordination between the chief surgeon and his or her assistant by limiting the visual plethora of the surgical field to the endoscopist, and the participation of an assistant was dependent on a verbal transliteration of the surgical field. Photodocumentation, so critical for consultation and education, was also severely hampered [13].

The introduction of a miniature electronic camera that transduced the afferent optical image into efferent electronic impulses with the help of a charge-coupled device (CCD) radically transformed the way in which endoscopy was performed [13]. Thus electronic video-endoscopy was born, combining the electronic endoscope and the television. The entire surgical team could now view the magnified images and collaboration between surgeons was taken to a whole new level.

Operating rooms equipped for robotic surgeries with the da Vinci Surgical System provided 3D stereoscopic vision for the operating surgeon but the assistants and allied personnel were only allowed to visualize a 2D version of the unfolding events. The “augmented-reality” surgical suite, first proposed and implemented by Shrivastava and Menon [14], made tangible stereoscopic 3D vision a reality for everyone in the operating room (Figure 1.1).

While the vision systems improved, the operating endoscopist’s ability to manipulate the surgical field themselves was still impaired by the assistant holding the camera in place. This is where robotic technology first made its mark. The first robot to have the US Food and Drug Administration (FDA)’s imprimatur was AESOP (Automated Endoscopic System for Optimal Positioning). Computer Motion (Berkeley,
The Evolution of Robotic Surgery and Its Clinical Applications

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The Evolution of Robotic Surgery and Its Clinical Applications

CA, USA), which first introduced AESOP in the mid-1990s, was initially funded by a NASA research grant for the development of a robotic arm for the US space program. AESOP used voice (or, alternatively, foot or hand) control to direct the movements of a robotic arm, which usually held the laparoscope (but could also hold a retractor). The surgeon used a preprogrammed voice card that allowed the device to understand and respond to his or her commands. Allaf et al. [15] examined the optimal interface (voice versus foot control) to manipulate the robot and found that foot control was faster but voice control was more accurate. Kavoussi et al. [16] found the laparoscopic camera positioning to be significantly steadier with less inadvertent movements when under robotic control and concluded that operative times during dissections were not significantly different between robot-assisted and human-assisted procedures.

Telepresence platforms

The da Vinci system

The state-of-the-art platform for the performance of telemanipulative procedures is the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA), which is a master–slave system. The system has three separate parts that dovetail to produce an immersive interface.

The console

The surgeon is ensconced at the console, which is designed as an ergonomically comfortable perch with his or her hands fitting into the “masters” (basically, freely mobile finger controls). In the United States, the FDA has made it mandatory for the console to be in the same room as the patient.

The console also consists of a stereoscopic viewer with sensors. The act of placing the (surgeon’s) head into the console vivifies the system and removing it deactivates and locks the robotic arms. The surgeon’s dexterous hand movements are electronically translated to the robotic instruments in direct contact with the operative target. Foot controls for camera positioning and diathermy complete the console.

Stereoscopic vision system

The stereoscopic vision system provides high-resolution 3D images of the operative field to the surgeon at his or her vantage point in the console. The binocular vision system, with images that combine magnification and depth resolution, is juxtaposed with the hand controls to produce an intuitive experience mimicking open surgery.

Surgical cart

The end effectors of the robotic system are in striking contrast to conventional laparoscopy, with the surgeon’s controls articulating wristed instruments with seven degrees of freedom (three orientation, three translational, and one for grip) and two degrees of axial rotation. The tools are also steadier than the human hand because it has an inbuilt tremor-filtering functionality. Variable motion scaling allows a versatile degree of motion of the instruments (as, e.g., a 3:1 ratio allows 3 cm of movement of the controls to translate into 1 cm of movement of the instruments in the operative field) and, combined with the magnified vision system, it becomes possible for the surgeon to finesse very nimble dissections in anatomic minefields.

Newer developments include a fourth arm (which gives the console surgeon greater independence and control), an integrated touchpad (for audio and video controls), and superior stereoscopic vision. TilePro allows the projection of intraoperative ultrasound images and preoperative computed tomography (CT) images on to the console screen for precise tumor resection [17]. The dual console systems are a step in the
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direction of enhanced interspecialty collaboration, providing a platform for the cross-pollination of ideas and sharing of instruments to develop a multidisciplinary robotic program.

Clinical applications

Cardiothoracic surgery

The da Vinci robot (as was the Zeus) was engineered specifically for the performance of minimally invasive cardiac surgery. In 1999, Carpentier and co-workers [18] reported the first totally endoscopic cardiac bypass (TECAB) procedure (LITA–LAD grafting) in Paris. All the surgeons underwent a preliminary evaluation phase during which they optimized the various steps in human cadavers. The rate-limiting step in attaining the “holy grail” of totally endoscopic closed-chest surgery was felt to be the optimal placement of ports in the rigid chest wall. The excellent kinematic (jointed) dexterity of the anastomotic step of surgery in a 3D vision environment was hailed as the signal feature of the robotic interface.

The FDA approval for robotic coronary revascularization (da Vinci) was the result [19] of a prospective multicentric Investigational Device Exemption (IDE) trial by Argenziano et al. [20]. Patients were enrolled for arrested-heart, single-vessel TECAB. The trial concluded that the TECAB had comparable results pertaining to efficacy (freedom from graft failure and reintervention) and safety (freedom from major adverse cardiac events) endpoints to conventional open surgery.

The new era of collaboration between minimally invasive cardiothoracic surgeons and interventional cardiologists then began in earnest. Katz et al. [21] reported a series of patients treated with “hybrid” revascularization – TECAB for the LITA–LAD grafting combined with percutaneous coronary intervention (PCI) for secondary coronary targets [22].

Urology

Schuessler et al. [23] reported the outcomes for the first transperitoneal laparoscopic prostatectomy series of nine patients and concluded that it offered no relative advantages in surgical outcomes (oncologic cure, potency, continence) and perioperative outcomes (length of stay, convalescence, cosmesis) as compared with the traditional procedure. They also reported other disadvantages – longer operating time, an exceptionally steep learning curve, and increased fixed (and variable) costs. Guillenou and Vallencien of the Montsouris group improved the technique that scaled down the operating time, duration of catheterization, and length of stay, and proffered equivalent oncologic efficacy and superior functional outcomes, all the while buoyed by a viable cost–benefit model at their institution [24].

Working in one of the earliest centers practicing robotic cardiac surgery, Binder and Kramer in Frankfurt performed the first robotically assisted radical prostatectomy in May 2000 [25].

Menon and colleagues at the Vattikuti Institute of Urology in Detroit were the first to demonstrate the advantages of robotic prostatectomy over the open procedure [26], and engineered a smooth transition from the Montsouris laparoscopic approach to a replicable robot-specific technique – the Vattikuti Institute prostatectomy [27]. The group also laid the anatomic foundations for the Veil of Aphrodite technique [28] (high anterior release of periprostatic fascia, Figure 1.2). Currently, the group has the largest published series [29] reporting excellent functional and surgical outcomes for the procedure. It was the work at the Vattikuti Urology Institute that laid the foundations for the acceptance of robotics as a viable surgical tool.

Figure 1.2 The “Veil of Aphrodite” after robot-assisted radical prostatectomy.
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Figure 1.3 The first complete intracorporeal robot-assisted laparoscopic augmentation ileocystoplasty and Mitrofanoff appendicovesicostomy. (a) Completed bowel anastomosis; (b) completed cystoplasty; (c) completed Mitrofanoff appendicovesicostomy. Courtesy of Dr. Mohan S. Gundeti.

Pediatric urology
The assimilation of laparoscopy into pediatric urology has lagged behind its adoption into adult urology \[30\]. Nevertheless, since its first introduction by Cortesi et al. \[31\] for the evaluation of impalpable testes, it has become an integral part of many reconstructive procedures in few select hands \[30\]. Robotic instruments have been tailored to facilitate pediatric surgery (5 mm instruments as opposed to the 8 mm instruments used in adults) and 2D/3D endoscopes have been developed.

A team of pediatric urologists led by Craig Peters and Joseph Borer at the Children’s Hospital Boston, who had regularly been performing complex laparoscopic surgery in the 1990s, performed one of the earliest robotic pediatric pyeloplasties in an adolescent with symptomatic ureteropelvic junction (UPJ) obstruction on 1 March 2002 (C. Peters, personal communication).

The most commonly performed procedure with robotic assistance is pyeloplasty for the UPJ obstruction. Other procedures that are performed using the robotic platform are nephrectomies, heminephroureterectomies, ureteral reimplantation, appendicovesicostomy, and orchiopexy, among others \[32\]. Ever more complex procedures are being performed laparoscopically with the added dexterity of the robot – a case in point being the report published by Gundeti et al. \[33\] of the first complete intracorporeal robotic-assisted laparoscopic augmentation ileocystoplasty and Mitrofanoff appendicovesicostomy (Figure 1.3).

General surgery
General surgery has proven less permissive to the adoption of robotic technology. Three reasons are commonly cited \[34\] for this early trend: relatively advanced laparoscopic skill sets in elective general surgeons, equipment limitations (particularly for bowel surgery), and procedural complexity (that would demand a robotic rather than laparoscopic intervention).

On 3 March 1997, Cadiere and colleagues, building on Dubois et al.’s established techniques of laparoscopic access \[35\], performed the first robot-assisted laparoscopic cholecystectomy on a 72-year-old woman at the St. Blasius hospital in Dendermonde, Belgium. The contemporary role of robotic cholecystectomy is controversial, with some regarding it as the ideal launch pad for getting on to the robotic learning curve \[36\] whereas others, among them some early pioneers \[37\] of the robotic approach, have reverted to the standard laparoscopic technique, citing cost-effectiveness.

Marescaux et al. \[38\] espoused a more sophisticated rationale for the dogged adoption of robotic cholecystectomy (and the robotic approach in
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general). They envisioned the integration of the different digital interfaces into an augmented-reality operating room, where preoperative images would permit entire simulative surgeries beforehand; the preoperative images and the resultant simulation would then integrate with real-time images to facilitate meticulous identification of anatomic structures (pathology, vasculature, anatomic aberrancy, margins) to a degree heretofore unknown, thereby completely transforming the surgical act into ever more manipulable digital data.

Numerous other procedures have also been performed with robotic assistance. One of the earliest was robotic Nissen fundoplication, which has been shown to have equivalent outcomes in a number of trials comparing it with the laparoscopic approach. At this juncture, robotics does appear to be more costly and surgeons early in the learning curve show longer operative times [34]. In contrast, reports have emerged that the difference disappeared with 10–20 operations for robotic fundoplication (and robotic cholecystectomy) [34]. As in other allied fields, the robotic approach offers special advantages when the need for precise intracorporeal suturing in confined spaces is paramount.

Conclusion

The events of the preceding decade have provided a strong affirmation for the versatility of the robotic interface. The arduous task of actually tailoring this amorphous platform to specific applications behoves a strong commitment by intrepid surgeons and maverick hospitals. Robotic surgery is the beginning and not the end of the journey to minimize further the therapeutic invasion of the human body. Its application to children appears to be intuitive but we need a dedicated robot, supported by finer tools, to handle pediatric surgical procedures. The equipment also needs to be molded to suit infantile needs. The current prohibitive costs of the robotic system have deprived large swathes of underprivileged patients of the benefits of minimally invasive procedures and it is to be hoped that this deplorable scenario will change in the near future.

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