The Vattikuti Urology Institute (VUI) at Henry Ford Hospital in Detroit, Michigan, USA established the first urologic robotic surgery program in the world in 2000. It would not have happened without 3 crucial factors: an innovative idea, an experienced surgeon with tremendous foresight, and considerable philanthropic funding. In keeping with the legacy of Henry Ford and the spirit of innovation, we sought to develop and improve upon techniques of minimally invasive prostate surgery. Initially, Dr. Mani Menon and his colleagues adopted a laparoscopic approach for radical prostatectomy in collaboration with Dr. Guy Vallencien and Dr. Bertrand Guillaneau, skilled surgeons from France. However, it became apparent that due to the different body habitus of American men compared to Europeans, the laparoscopic approach was not as comparable to the retropubic approach as expected. The advent of a robotic surgical system approved for cardiac surgery offered a potential solution. Dr. Menon’s experience informed his foresight in seeking to apply the surgical robot to urologic surgery. With the generous support from the Raj and Padma Vattikuti Foundation, a perfect storm gathered to initiate our journey into the robotic era.

**RADICAL PROSTATECTOMY**

The first radical prostatectomy was performed by the perineal approach in 1903 by Young [1], and the first retropubic approach described by Millin [2] in 1947. The current concept of retropubic radical nerve-sparing prostatectomy was established by Patrick Walsh et al. [3] in 1982. Novel approaches using laparoscopy were introduced starting in the 1990s, and the robotic approach in prostate surgery was introduced in originally in 2000 and at that time, only a few studies showed feasibility via a case report or series without clinical benefits [4-6]. The robotic approach has now been adopted exponentially since its introduction in 2000, when it was conceived as the Vattikuti Institute Prostatectomy (VIP) [7].
Demonstrating a benefit in terms of perioperative outcomes reflected the initial experience with robotic prostatectomy at the VUI. Patients undergoing robot-assisted prostatectomy had shorter operating room times, lower estimated blood loss (EBL), lower complication rates, earlier urethral catheter removals, and a shorter hospital length of stay [8,9]. Functional outcomes in terms of continence and potency were also improved. These benefits were attributed to the surgical robot’s 3-dimensional vision, high quality and intuitive controls, and high degree of freedom in instrument movements. Although oncological outcomes and positive surgical margin (PSM) rates are equivalent between robot-assisted radical prostatectomy (RARP) and radical retropubic prostatectomy (RRP), RARP may have a benefit in a long-term cancer-recurrence free survival rate in D’Amico-classification high-risk prostate cancer patients [10-12]. A systematic review by Ficarra et al. [13] revealed that functional outcomes were favorable in RARP over RRP. Most of all, the enhanced visualization and dexterity of the surgical robot have helped to reduce postoperative complication rates, as demonstrated in a series of 3,317 patients by Agarwal et al. [14] in 2011.

The surgical technique in robotic prostatectomy has evolved in many ways over the last 15 years. Initial surgical technique imitated a laparoscopic approach, which started posteriorly to dissect the seminal vesicles and vasa deferentia, followed by the bladder takedown to approach the bladder neck. It was not long before this posterior approach was supplanted by what we now think of as the VIP technique, wherein the prostate is approached anteriorly, starting with the bladder takedown, followed by the bladder neck, then dissection of the seminal vesicles and vasa deferentia. This change enabled the robotic approach to be applied on patient populations with higher body mass indices. Furthermore, progressive anatomic studies revealed that the neural tissue was not confined to a “neurovascular bundle,” but rather spread over the wider surface of the prostatic fascia [15,16]. We hypothesized that the preserved neural tissue of the anterolateral aspects of the periprostatic fascial layer, which we named the, “Veil of Aphrodite,” could potentially allow for greater nerve preservation [17]. We found that a bilateral “Veil of Aphrodite” technique used in men with localized prostate cancer and normal baseline erectile function resulted in better recovery of postoperative erectile function and a higher percentage of erections firm enough for intercourse at 12 months postoperatively, compared to men undergoing a standard bilateral nerve sparing technique [18].

Although a double-layered urethrovésical anastomosis (UVA)—consisting of posterior rhabdosphincteric reconstruction, as well as, lateral and anterior reconstruction—was expected to show an early return of urinary control, a randomized control trial in our institution demonstrated no advantages to double-layered UVA compared with single-layered UVA on early continence recovery or long-term continence rates [19-21]. However, double-layered UVA did show a significant decrease in cystographic leaks compared to single-layered UVA [22].

At the VUI in 2007, the urinary diversion for UVA has been done with the aid of a percutaneous suprapubic tube (SPT) instead of the conventional method of utilizing a urethral Foley catheter [23]. The benefits of the SPT are less catheter-related discomfort, decreased need for anticholinergic medications for bladder spasm related symptoms, and reduced risk of urethral or meatal strictures, without increasing the risk of bladder neck contractures [24].

The standard technique for the UVA was using a double-armed monocril suture in a running fashion until the Food and Drug Administration (FDA) approved the polyglyconate-barbed suture for soft tissue approximation in 2010 [25]. The barbed suture reduced the anastomotic time by 26% without compromising outcomes, compared with the conventional monofilament suture.

Most recently the GelPOINT (Applied Medical, Rancho Santa Margarita, CA, USA) has been applied for our VIP technique along with renal surgery which will be described later, for real time bedside bimanual examination of the specimen, and for regional hypothermia by introducing ice slush, the Intracorporeal Cooling and Extraction (ICE) technique [26]. By applying the ICE technique with the use of the GelPOINT, and real time bimanual examination, the absolute risk of PSM in pT3a disease was reduced by 26.6%. The impact of regional hypothermia by cooling the neurovascular bundle is currently being evaluated as short-term outcomes were unclear.

**RADICAL CYSTECTOMY**

Radical cystectomy (RC) has been the gold standard of treatment for patients with muscle invasive bladder cancer, and now minimally invasive techniques have been adopted as the treatment of choice [27,28]. Robot-assisted radical cystectomy (RARC), as described by Menon et al. [29] in 2003, involved nerve sparing techniques adopted from the VIP method. The robotic approach has noted an early return of bowel function, decreased length of stay and lower estimated blood loss in the short term [30,31]. Nix et al. [32] published a prospective randomized controlled trial of RARC....
in 2010, with lymph node yield as a primary end point, and concluded that the robotic approach was non-inferior to the open approach.

A multi-institutional cohort database from the International Robotic Cystectomy Consortium (IRCC), with approximately 450 lymphadenectomies, revealed that the yield of lymph nodes retrieved between the robotic and open approaches were similar, obtaining an average of eighteen lymph nodes [33]. Davis et al. [34] reported a series in which the lymph node yield was forty-three, with an efficiency of 93%. On second look lymphadenectomy by the open approach, no residual lymphatic tissue was seen in 80% of the cases.

As we know, RC is associated with significant perioperative morbidity and mortality along with changes in the patient’s quality of life. There have been a few series that have described a reduced rate of complications in patients who underwent RARC vs. open radical cystectomy (ORC) [31,32,35,36]. Specifically, Musch et al. [36] reported that patient’s who underwent RARC experienced fewer postoperative adverse events of any Clavien-Dindo grade complication <90 days and <60 days after surgery, lower frequency of major complications, decreased estimated blood loss and transfusion requirement compared to the ORC arm. The lower risk of adverse perioperative outcomes with RARC would have potential benefits in the elderly population and has been shown to be a feasible treatment option in this age group (≥80 years old) with acceptable perioperative morbidity and short-term oncologic control [37]. Richards et al. [38] described in a single-institution prospective cohort study of 20 patients aged 75 years or older, there were fewer postoperative complications in those who underwent RARC, compared to those who underwent ORC. The RARC arm was an independent predictor of fewer overall and major adverse effects.

Khan et al. [39] reported the oncologic control of local disease in patients who underwent RARC after a follow-up period of 8 years were similar to the outcomes of patients who had ORC. Several other series and reviews have also demonstrated comparable oncologic outcomes between ORC and RARC [40-42]. However, RARC has the added benefit of offering a minimally invasive approach with smaller surgical incisions, which results in less postoperative pain and shorter hospital course. Albeit some of these studies were limited to a single surgeon or institution, these results should encourage a more robust, randomized controlled trial to ascertain select patients or institutions that can efficiently optimize these potential benefits.

In 2003, Menon et al. [29] published a pioneering RARC series of 17 cases. The 5- to 6-cm suprapubic incision, made for cystoprostatectomy specimen removal, was used to create an extracorporeal neobladder or ileal conduit. The created pouch was internalized, and the neo-vesicourethral anastomosis was completed with robotic assistance after closure of incision. The initial RARC technique was developed with collaboration with Dr. Mohamed A. Ghoneim’s group in Mansoura, Egypt, where the majority of urinary diversions were created using the W-pouch technique. The extracorporeal technique progressed into an intracorporeal technique with robot-assisted suturing dexterity as well as new advances in stapling devices. Multicentric IRCC data for 90-day postoperative follow-up has recently been published, comparing intracorporeal and extracorporeal urinary diversions, 167 vs. 768, respectively [43]. The operative time and median hospital stay were comparable, as were reoperation rates and complication rates. As expected with less bowel manipulation, gastrointestinal complications were significantly less in the intracorporeal group.

**UPPER URINARY TRACT SURGERY**

Partial nephrectomy (PN) is the gold standard treatment for small renal masses (SRMs). Compared to radical nephrectomy, PN has been shown to confer a survival advantage, similar oncologic outcomes, and minimizes the chance of severe chronic kidney disease in patients with associated renal dysfunction in the future [44-46]. Laparoscopic partial nephrectomy (LPN) is more commonly performed, has comparable oncologic control, less morbidity and shorter postoperative recovery period compared to open partial nephrectomy (OPN) [47]. However, LPN is more technically challenging, requires advanced surgical skills to achieve a negative tumor margin and to perform complex renal reconstruction, and has a steeper learning curve [48]. The advent of the robotic platform transformed the realm of upper tract surgery, and robot-assisted nephrectomies were performed starting in January 2004. With minimally invasive PN becoming the standard of care for renal tumors <4 cm in size, we published our initial experience of robot-assisted partial nephrectomy (RAPN) in 10 patients with mean tumor size of 2 cm [49]. In order to improve minimally invasive surgical skills, we devised novel laboratory models for solid renal tumor (“pseudotumor”) and renal vein tumor thrombus (“pseudothrombus”) in pigs and cadavers [50]. Techniques of RAPN were continuously refined and in 2009, we illustrated our four-arm technique of RAPN using a transperitoneal approach, highlighting the role of the fourth
arm for renal hilar dissection, vascular control and during renorrhaphy [51]. The Tile-Pro feature of the da Vinci robotic system allowed visualization of intraoperative ultrasound and preoperative imaging study as a picture-on-picture image on the console screen to aid tumor margin identification [52]. Development of robotic bulldog clamps and intraoperative ultrasound probes gave further functional autonomy to the console surgeon by reducing his dependence on the variably skilled patient-side assistant [53,54]. The first report on the single-surgeon, single-center experience of RAPN for renal tumors was published from our institution, comparing T1a with larger tumors. We found equivalent EBL, total operative time, length of stay, complication rates and change in estimated glomerular filtration rate in the 2 groups [55]. Multi-institutional series later confirmed our results even for more complex tumors and in obese patients [56,57].

Various techniques for minimally invasive PN, like sliding clip renorrhaphy and early unclamping, appeared in an effort to reduce warm ischemia. Encouraged with the success of UVA with barbed suture during VIP, we established its safety and feasibility of a two-layered, running closure of the collecting system and renal capsule during renorrhaphy, and significantly lowering warm ischemia time (WIT) compared to the standard polyglactin suture (185 minutes vs. 247 minutes, respectively p<0.008) [58].

As regional hypothermia would expand the window for duration of permissible ischemia, we successfully experimented with the GelPOINT access platform to introduce ice-slush. With a mean cold ischemia time of 196 minutes and mean EBL of 296 mL, the technique of intracorporeal cooling was successfully used to achieve reproducible results [59].

Retroperitoneal access to the kidney obviates the need for bowel mobilization, and may reduce bowel related complications, pain management issues, as well as length of hospital stay. This approach will also confine blood and urine leaks to retroperitoneum, and may maximize the effectiveness of hypothermia techniques in the limited retroperitoneal space. Our recent description of robot-assisted retroperitoneal PN, which permits direct access to renal hilum for posterior and hilar tumors, is an effort in this direction [60]. A multicentric study by Hu et al. [61] showed retroperitoneal RAPN to have an acceptable morbidity and cancer control outcomes over a median follow-up of 27 years, proving retroperitoneal RAPN to be a reasonable alternative for patients with posterior renal masses or with prior abdominal surgery.

Recent trends show a resounding interest in the use of robot-assisted partial nephrectomy (RAPN) over LPN [62]. There are reported benefits and for some outcome measures, a superiority of RAPN over OPN and LPN [63-65]. The “trifecta” (which comprises a WIT<25 minutes, negative surgical margins and zero perioperative complications) has been used as a surrogate for quality of surgery in patients undergoing PN [66,67]. In a single-surgeon series of 500 patients, RAPN achieved the “trifecta” in almost 30% of the cases, with better operative outcomes and lower perioperative complications than compared to LPN [67]. RAPN is associated with a decreased length of stay, decreased intraoperative blood loss, and is less affected by the complexity of the renal tumor [68,69]. RAPN also offers a shorter WIT, which is a surrogate for final outcomes and achieves an overall better “trifecta” compared to LPN [66,70].

RAPN has a shorter learning curve than LPN and addresses some of the technical difficulties associated with the laparoscopic approach. Commonly cited advantages over LPN include a shorter learning curve with a wider range of indications, comparable or better operative, functional and oncologic outcomes, and better perioperative morbidity [48,63].

We described the feasibility of robot-assisted extended pyelolithotomy in 13 patients with staghorn calculi with a mean operative time of 158 minutes, mean console time 108 minutes, and EBL 100 mL, achieving stone free status in all but one patient [71]. Eun et al. [72] described a four-port “baseball diamond” strategy of port placement for patients undergoing nephroureterectomy to allow instrument access to the ipsilateral upper and lower urinary tract in the same operative session, without repositioning the patient and redocking the robot [72]. Utilizing the robotic magnification and precision in movement for micro dissection of anatomical planes around the adrenal gland, a four-step technique of robot-assisted right adrenalectomy and synchronous bilateral adrenalectomy were described [73,74].

**NEWER FRONTIERS IN ROBOTICS SURGERY**

The application of robot-assisted surgery continues to expand as technical improvements and surgeon experience continues to develop. Other notable areas where the robotic system are used include pediatrics, solid organ transplant, endocrine and gastrointestinal surgery. Early experience has found robotic surgery to be a feasible option in renal, pancreatic, thyroid, gastrointestinal transplantation, and in gynecologic surgery [75-79].

The first robot-assisted living donor kidney transplantation (RAKT) was performed in 2000 [80]. Since then, numerous reports of good renal graft outcomes, perioperative outcomes...
and reduced morbidity and mortality have been published [81-83]. RAKT is particularly useful in obese patients and more appealing to would-be donors given the smaller surgical incisions, decreased postoperative pain, estimated blood loss, and shorter length of hospital stay. There is also decreased associated morbidity and mortality intra and postoperatively and better cosmesis [84,85]. In obese patients, RAKT reduces the risk of surgical site infection, which is very important for the transplanted graft and newly immunosuppressed recipient [86,87].

Robotic techniques are continuously getting refined and reestablished. Dr. Mani Menon originally modified the RARP as the VUI technique via a standard anterior approach in 2001. However, recently Bocciardi group from Italy and Rha group from South Korea have tried a posterior approach, retzius-sparing prostatectomy (RSP) [88,89]. Although the learning curve on perioperative outcomes, such as operating time and PSMs, were noted in their data, the RSP has potential benefits on the achievement on continence. The early experience of the RSP in our institution also showed similar outcomes of early return of urinary continence. With the use of the GelPOINT at our institution for immediate bimanual palpation, the initial learning curve for PSMs has reduced, although long-term oncological outcomes still need to be evaluated through a large prospective cohort or randomized controlled trial.

The robotic platform has even adopted into the pediatric population. In children with ureteropelvic junction obstruction, robot-assisted pyeloplasty is associated with significantly shorter length of stay, which directly correlates with decreased loss of parental wages and hospitalization cost [90-92]. The robotic approach enhances the laparoscopic technique, while maintaining the additional advantage of decreased pain, length of stay, rapid recuperation, and better long term cosmesis [93]. Robot-assisted laparoscopic ureteroureterostomy (RALUU) has been shown to be a viable option in patients with duplicated and single system ureters. This also results in operative times and complication rates comparable to the open approach. However, a slightly shorter hospital stay was observed in children who underwent RALUU [94].

THE FUTURE OF ROBOTIC SURGERY

Currently, Intuitive Surgical (Sunnyvale, CA, USA) is leading the market of robotic surgical systems, and 11 major companies are sharing the rest of the market. According to the report from the Wintergreen Research Company, robotic surgical systems collectively markets at $3.4 billion in 2014 are anticipated to reach up to $20 billion by 2021. New surgical robotic systems will continue to approach the market, but the leaders in robotic surgical system will still be Intuitive Surgical’s da Vinci surgical system. As of December 2015, 3,977 da Vinci surgical systems were installed in the world.

The da Vinci surgical system was approved for a cardiac surgery in 1999 by the FDA and applied for prostate cancer in 2000. The application of da Vinci system has since been extended within the urologic field to include the kidney, bladder, reconstructive urologic surgery, and even to kidney transplantation. Evolution of robotic approach might expand its boundary toward new techniques to replace the established open and laparoscopic surgical techniques, or its indication from localized tumor to the locally advanced disease.

Initially, the idea of a robot-assisted surgical system was driven by the Navy and designed to enable a surgeon to perform tele-surgery. However, this has not been possible since the master and slave systems are connected through signals travelling close to light speed, and the delay between the movements of a surgeon and the machine increases with longer distance.

CONCLUSIONS

Minimally invasive surgical techniques have been expanding the boundary of application on urologic surgeries, because of the decreasing rate of perioperative outcomes and similar oncological results. Due to intuitive movements with advanced wrist movements, 3-dimensional vision and surgeon’s ergonomics, the robotic surgical technique has replaced the laparoscopic technique in many urological applications. Robotic surgery continues to evolve into newer techniques and refine the past techniques.

The market growth and the competition of newer surgical systems should translate to improvement of surgical technique and clinical outcomes.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

REFERENCES

1. Young HH. VIII. Conservative perineal prostatectomy: the results of two years’ experience and report of seventy-five cases. Ann Surg 1905;41:549-57.
2. Millin T. Retropubic prostatectomy; a new extravesical tech-
3. Walsh PC, Lepor H, Eggleston JC. Radical prostatectomy with preservation of sexual function: anatomic and pathological considerations. Prostate 1983;4:473-85.

4. Abbou CC, Hoznek A, Salomon L, Lobontiu A, Saint F, Cicco A, et al. Remote laparoscopic radical prostatectomy carried out with a robot: report of a case. Prog Urol 2000;10:520-3.

5. Abbou CC, Hoznek A, Salomon L, Olsson LE, Lobontiu A, Saint F, et al. Laparoscopic radical prostatectomy with a remote controlled robot. J Urol 2001;165(6 Pt 1):1964-6.

6. Pasticier G, Rietbergen JB, Guillonneau B, Fromont G, Menon M, Vallancien G. Robotically assisted laparoscopic radical prostatectomy: feasibility study in men. Eur Urol 2001;40:70-4.

7. Lowrance WT, Eastham JA, Savage C, Maschino AC, Laudone VP, Dechet CB, et al. Contemporary open and robotic radical prostatectomy practice patterns among urologists in the United States. J Urol 2012;187:2087-92.

8. Menon M, Shrivastava A, Tewari A, Sarle R, Hemal A, Peabody JO, et al. Laparoscopic and robot assisted radical prostatectomy: establishment of a structured program and preliminary analysis of outcomes. J Urol 2002;168:945-9.

9. Menon M, Tewari A, Baize B, Guillonneau B, Vallancien G. Prospective comparison of radical retropubic prostatectomy and robot-assisted anatomic prostatectomy: the Vattikuti Urology Institute experience. Urology 2002;60:864-8.

10. Abdollah F, Sood A, Sammon JD, Hsu L, Beyer B, Moschini M, et al. Long-term cancer control outcomes in patients with clinically high-risk prostate cancer treated with robot-assisted radical prostatectomy: results from a multi-institutional study of 1100 patients. Eur Urol 2015;68:497-505.

11. Lee EK, Baack J, Duchene DA. Survey of practicing urologists: robotic versus open radical prostatectomy. Can J Urol 2010;17:5094-8.

12. Novara G, Ficarra V, Mocellin S, Ahlering TE, Carroll PR, Graefen M, et al. Systematic review and meta-analysis of studies reporting oncologic outcome after robot-assisted radical prostatectomy. Eur Urol 2012;62:382-404.

13. Ficarra V, Novara G, Rosen RC, Artibani W, Carroll PR, Costello A, et al. Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. Eur Urol 2012;62:405-17.

14. Agarwal PK, Sammon J, Bhandari A, Dabaja A, Diaz M, Dusik-Fenton S, et al. Safety profile of robot-assisted radical prostatectomy: a standardized report of complications in 3317 patients. Eur Urol 2011;59:684-98.

15. Kiyoshima K, Yokomizo A, Yoshida T, Tomita K, Yonemasu H, Nakamura M, et al. Anatomical features of periprostatic tissue and its surroundings: a histological analysis of 79 radical retropubic prostatectomy specimens. Jpn J Clin Oncol 2004;34:463-8.

16. Costello AJ, Brooks M, Cole OF. Anatomical studies of the neurovascular bundle and cavernosal nerves. BJU Int 2004;94:1071-6.
al. Radical cystectomy in the treatment of invasive bladder cancer: long-term results in 1,054 patients. J Clin Oncol 2001;19:666-75.

28. Witjes JA, Compérat E, Cowan NC, De Santis M, Gakis G, Lebret T, et al. EAU guidelines on muscle-invasive and metastatic bladder cancer: summary of the 2013 guidelines. Eur Urol 2014;65:778-92.

29. Menon M, Hemal AK, Tewari A, Shrivastava A, Shoma AM, El-Tabey NA, et al. Nerve-sparing robot-assisted radical cystoprostatectomy and urinary diversion. BJU Int 2003;92:232-6.

30. Canda AE, Atmaca AF, Altinova S, Akbulut Z, Balbay MD. Robot-assisted nerve-sparing radical cystectomy with bilateral extended pelvic lymph node dissection (PLND) and intracorporeal urinary diversion for bladder cancer: initial experience in 27 cases. BJU Int 2012;110:434-44.

31. Novara G, Catto JW, Wilson T, Annerstedt M, Chan K, Murphy DG, et al. Systematic review and cumulative analysis of perioperative outcomes and complications after robot-assisted radical cystectomy. Eur Urol 2015;67:367-401.

32. Nix J, Smith A, Kurpad R, Nielsen ME, Wallen EM, Pruthi RS. Prospective randomized controlled trial of robotic versus open radical cystectomy for bladder cancer: perioperative and pathologic results. Eur Urol 2010;57:196-201.

33. Marshall SJ, Hayn MH, Stegemann AP, Agarwal PK, Badani KK, Balbay MD, et al. Impact of surgeon and volume on extended lymphadenectomy at the time of robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium (IRCC). BJU Int 2013;111:1075-80.

34. Davis JW, Gaston K, Anderson R, Dinney CP, Grossman HB, Munsell MF, et al. Robot assisted extended pelvic lymphadenectomy at radical cystectomy: lymph node yield compared with second look open dissection. J Urol 2011;185:79-83.

35. Ng CK, Kaufman EC, Lee MM, Otto BJ, Portnoff A, Ehrlich JR, et al. A comparison of postoperative complications in open versus robotic cystectomy. Eur Urol 2010;57:274-81.

36. Musch M, Janowski M, Steves A, Roggenbuck U, Boergers A, Davoudi Y, et al. Comparison of early postoperative morbidity after robot-assisted and open radical cystectomy: results of a prospective observational study. BJU Int 2014;113:458-67.

37. Nguyen DP, Al Hussein Al Awamih B, Charles Osterberg E, Chrystal J, Flynn T, Lee DJ, et al. Postoperative complications and short-term oncological outcomes of patients aged ≥80 years undergoing robot-assisted radical cystectomy. World J Urol 2015;33:1315-21.

38. Richards KA, Kader AK, Otto R, Pettus JA, Smith JJ 3rd, Hemal AK. Is robot-assisted radical cystectomy justified in the elderly? A comparison of robotic versus open radical cystectomy for bladder cancer in elderly ≥75 years old. J Endourol 2012;26:1301-6.

39. Khan MS, Elhage O, Challacombe B, Murphy D, Coker B, Rimington P, et al. Long-term outcomes of robot-assisted radical cystectomy for bladder cancer. Eur Urol 2013;64:219-24.

40. Yuh B, Torrey RR, Ruel NH, Wittig K, Tobis S, Linehan J, et al. Intermediate-term oncologic outcomes of robot-assisted radical cystectomy for urothelial carcinoma. J Endourol 2014;28:939-45.

41. Yuh B, Wilson T, Bochner B, Chan K, Palou J, Stenzl A, et al. Systematic review and cumulative analysis of oncologic and functional outcomes after robot-assisted radical cystectomy. Eur Urol 2015;67:402-22.

42. Snow-Lisy DC, Campbell SC, Gill IS, Hernandez AV, Fergany A, Kaouk J, et al. Robotic and laparoscopic radical cystectomy for bladder cancer: long-term oncologic outcomes. Eur Urol 2014;65:193-200.

43. Ahmed K, Khan SA, Hayn MH, Agarwal PK, Badani KK, Balbay MD, et al. Analysis of intracorporeal compared with extracorporeal urinary diversion after robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. Eur Urol 2014;65:340-7.

44. Huang WC, Elkin EB, Levey AS, Jang TL, Russo P. Partial nephrectomy versus radical nephrectomy in patients with small renal tumors: is there a difference in mortality and cardiovascular outcomes? J Urol 2009;181:55-61.

45. Kim SP, Thompson RH, Boorjian SA, Weight CJ, Han LC, Murad MH, et al. Comparative effectiveness for survival and renal function of partial and radical nephrectomy for localized renal tumors: a systematic review and meta-analysis. J Urol 2012;188:51-7.

46. Medina-Polo J, Romero-Otero J, Rodriguez-Antolin A, Dominguez-Esteban M, Passas-Martinez J, Villacampa-Auba F, et al. Can partial nephrectomy preserve renal function and modify survival in comparison with radical nephrectomy? Scand J Urol Nephrol 2011;45:143-50.

47. Mottrie A, De Naeyer G, Schatteman P, Carpentier P, Sangalli M, Ficarra V. Impact of the learning curve on perioperative outcomes in patients who underwent robotic partial nephrectomy for parenchymal renal tumours. Eur Urol 2010;58:127-32.

48. Cha EK, Lee DJ, Del Pizzo JJ. Current status of robotic partial nephrectomy (RPN). BJU Int 2011;108(6 Pt 2):935-41.

49. Kaul S, Laungani R, Sarle R, Stricker H, Peabody J, Littleton R, et al. da Vinci-assisted robotic partial nephrectomy: technique and results at a mean of 15 months of follow-up. Eur Urol 2007;51:186-91.

50. Eun D, Bhandari A, Boris R, Lyall K, Bhandari M, Menon M, et al. A novel technique for creating solid renal pseudotumors and renal vein-inferior vena cava pseudothrombus in a porcine and cadaveric model. J Urol 2008;180:1510-4.
51. Patel MN, Bhandari M, Menon M, Rogers CG. Robotic-assisted partial nephrectomy: Has it come of age? Indian J Urol 2009;25:523-8.
52. Rogers CG, Laungani R, Bhandari A, Krane LS, Eun D, Patel MN, et al. Maximizing console surgeon independence during robot-assisted renal surgery by using the Fourth Arm and TilePro. J Endourol 2009;23:115-21.
53. Sukumar S, Petros F, Mander N, Chen R, Menon M, Rogers CG. Robotic partial nephrectomy using robotic bulldog clamps. JSLS 2011;15:520-6.
54. Kaczmarek BF, Sukumar S, Petros F, Trinh QD, Mander N, Chen R, et al. Robotic ultrasound probe for tumor identification in robotic partial nephrectomy: Initial series and outcomes. Int J Urol 2013;20:172-6.
55. Patel MN, Krane LS, Bhandari A, Laungani RG, Shrivastava A, Siddiqui SA, et al. Robotic partial nephrectomy for renal tumors larger than 4 cm. Eur Urol 2010;57:310-6.
56. Petros F, Sukumar S, Haber GP, Dulabon L, Bhayani S, Stifelman M, et al. Multi-institutional analysis of robot-assisted partial nephrectomy for renal tumors >4 cm versus ≤ 4 cm in 445 consecutive patients. J Endourol 2012;26:642-6.
57. Naeem N, Petros F, Sukumar S, Patel M, Bhandari A, Kaul S, et al. Robot-assisted partial nephrectomy in obese patients. J Endourol 2011;25:101-5.
58. Sammon J, Petros F, Sukumar S, Bhandari A, Kaul S, Menon M, et al. Barbed suture for renorrhaphy during robot-assisted partial nephrectomy. J Endourol 2011;25:529-33.
59. Rogers CG, Ghani KR, Kumar RK, Jeong W, Menon M. Robotic partial nephrectomy with cold ischemia and on-clamp tumor extraction: recapitulating the open approach. Eur Urol 2013;63:573-8.
60. Ghani KR, Porter J, Menon M, Rogers C. Robotic retroperitoneal partial nephrectomy: a step-by-step guide. BJU Int 2014;114:311-3.
61. Hu JC, Treat E, Filson CP, McLaren I, Xiong S, Stepanian S, et al. Technique and outcomes of robot-assisted retroperitoneoscopic partial nephrectomy: a multicenter study. Eur Urol 2014;66:542-9.
62. Dev HS, Sooriakumaran P, Stolzenburg JU, Anderson CJ. Is robotic technology facilitating the minimally invasive approach to partial nephrectomy? BJU Int 2012;109:760-8.
63. Zhang X, Shen Z, Zhong S, Zhu Z, Wang X, Xu T. Comparison of peri-operative outcomes of robot-assisted vs laparoscopic partial nephrectomy: a meta-analysis. BJU Int 2013;112:1133-42.
64. Masson-Lecomte A, Yates DR, Hupertan V, Haertig A, Chartier-Kastler E, Bitker MO, et al. A prospective comparison of the pathologic and surgical outcomes obtained after elective treatment of renal cell carcinoma by open or robot-assisted partial nephrectomy. Urol Oncol 2013;31:924-9.
65. Aboumarzouk OM, Stein RJ, Eyraud R, Haber GP, Chlosta PL, Somani BK, et al. Robotic versus laparoscopic partial nephrectomy: a systematic review and meta-analysis. Eur Urol 2012;62:1023-33.
66. Zargar H, Allaf ME, Bhayani S, Stifelman M, Rogers C, Ball MW, et al. Trifecta and optimal perioperative outcomes of robotic and laparoscopic partial nephrectomy in surgical treatment of small renal masses: a multi-institutional study. BJU Int 2015;116:407-14.
67. Khalifeh A, Autorino R, Hillyer SP, Laydner H, Eyraud R, Panumatrassamee K, et al. Comparative outcomes and assessment of trifecta in 500 robotic and laparoscopic partial nephrectomy cases: a single surgeon experience. J Urol 2013;189:1236-42.
68. Benway BM, Bhayani SB, Rogers CG, Dulabon LM, Patel MN, Lipkin M, et al. Robot assisted partial nephrectomy versus laparoscopic partial nephrectomy for renal tumors: a multi-institutional analysis of perioperative outcomes. J Urol 2009;182:666-72.
69. Long JA, Yakoubi R, Lee B, Guillotreau J, Autorino R, Laydner H, et al. Robotic versus laparoscopic partial nephrectomy for complex tumors: comparison of perioperative outcomes. Eur Urol 2012;61:1257-62.
70. Zargar H, Autorino R, Akca O, Brandao LF, Laydner H, Kaouk J. Minimally invasive partial nephrectomy in the age of the ‘trifecta’. BJU Int 2015;116:505-6.
71. Badani KK, Hemal AK, Fumo M, Kaul S, Shrivastava A, Rajendram AK, et al. Robotic extended pyelolithotomy for treatment of renal calculi: a feasibility study. World J Urol 2006;24:198-201.
72. Eun D, Bhandari A, Boris R, Rogers C, Bhandari M, Menon M. Concurrent upper and lower urinary tract robotic surgery: strategies for success. BJU Int 2007;100:1121-5.
73. Krane LS, Shrivastava A, Eun D, Narra V, Bhandari M, Menon M. A four-step technique of robotic right adrenalectomy: initial experience. BJU Int 2008;101:1289-92.
74. Malley D, Boris R, Kaul S, Eun D, Muhletaler F, Rogers C, et al. Synchronous bilateral adrenalenuctomy for adrenocorticotropic-dependent Cushing’s syndrome. JSLS 2008;12:198-201.
75. Laydner H, Isaac W, Autorino R, Kassab A, Yakoubi R, Hillyer S, et al. Single institutional cost analysis of 325 robotic, laparoscopic, and open partial nephrectomies. Urology 2013;81:533-8.
76. Byeon HK, Ban MJ, Lee JM, Ha JG, Kim ES, Koh YW, et al. Robot-assisted Sistrunk’s operation, total thyroidectomy, and neck dissection via a transaxillary and retroauricular (TARA) approach in papillary carcinoma arising in thyroglossal duct cyst and thyroid gland. Ann Surg Oncol 2012;19:4259-61.
77. Health Quality Ontario. Robotic-assisted minimally invasive
surgery for gynecologic and urologic oncology: an evidence-based analysis. Ont Health Technol Assess Ser 2010;10:1-118.

78. Tzvetanov I, D’Amico G, Bejarano-Pineda L, Benedetti E. Robotic-assisted pancreas transplantation: where are we today? Curr Opin Organ Transplant 2014;19:80-2.

79. Tzvetanov I, Bejarano-Pineda L, Giulianotti PC, Jeon H, Garcia-Roca R, Bianco F, et al. State of the art of robotic surgery in organ transplantation. World J Surg 2013;37:2791-9.

80. Horgan S, Vanuno D, Sileri P, Cicallese L, Benedetti E. Robotic-assisted laparoscopic donor nephrectomy for kidney transplantation. Transplantation 2002;73:1474-9.

81. Tzvetanov I, D’Amico G, Benedetti E. Robotic-assisted kidney transplantation: our experience and literature review. Curr Transplant Rep 2015;2:122-6.

82. Tsai MK, Lee CY, Yang CY, Yeh CC, Hu RH, Lai HS. Robot-assisted renal transplantation in the retroperitoneum. Transplant Int 2014;27:452-7.

83. Cohen AJ, Williams DS, Bohorquez H, Bruce DS, Carmody IC, Reichman T, et al. Robotic-assisted laparoscopic donor nephrectomy: decreasing length of stay. Ochsner J 2015;15:19-24.

84. Sood A, Jeong W, Peabody JO, Hemal AK, Menon M. Robot-assisted radical prostatectomy: inching toward gold standard. Urol Clin North Am 2014;41:473-84.

85. Trinh QD, Sammon J, Sun M, Ravi P, Ghani KR, Bianchi M, et al. Perioperative outcomes of robot-assisted radical prostatectomy compared with open radical prostatectomy: results from the nationwide inpatient sample. Eur Urol 2012;61:679-85.

86. Lynch RJ, Ranney DN, Shijiie C, Lee DS, Samala N, Englesbe MJ. Obesity, surgical site infection, and outcome following renal transplantation. Ann Surg 2009;250:1014-20.

87. Tzvetanov I, Giulianotti PC, Bejarano-Pineda L, Jeon H, Garcia-Roca R, Bianco F, et al. Robotic-assisted kidney transplantation. Surg Clin North Am 2013;93:1309-23.

88. Galfano A, Di Trapani D, Sozzi F, Strada E, Petralia G, Bramieri M, et al. Beyond the learning curve of the Retzius-sparing approach for robot-assisted laparoscopic radical prostatectomy: oncologic and functional results of the first 200 patients with ≥ 1 year of follow-up. Eur Urol 2013;64:974-80.

89. Lim SK, Kim KH, Shin TY, Han WK, Chung BH, Hong SJ, et al. Retzius-sparing robot-assisted laparoscopic radical prostatectomy: combining the best of retropubic and perineal approaches. BJU Int 2014;114:236-44.

90. Behan JW, Kim SS, Dorey F, De Filippo RE, Chang AY, Hardy BE, et al. Human capital gains associated with robotic assisted laparoscopic pyeloplasty in children compared to open pyeloplasty. J Urol 2011;186(4 Suppl):1663-7.

91. Badwan K, Bhayani S. Robotic pyeloplasty: a critical appraisal. Int J Med Robot 2007;3:20-2.

92. Shah KK, Louie M, Thaly RK, Patel VR. Robot assisted laparoscopic pyeloplasty: a review of the current status. Int J Med Robot 2007;3:35-40.

93. Uberoi J, Disick GI, Munver R. Minimally invasive surgical management of pelvic-ureteric junction obstruction: update on the current status of robotic-assisted pyeloplasty. BJU Int 2009;104:1722-9.

94. Lee NG, Corbett ST, Cobb K, Bailey GC, Burns AS, Peters CA. Bi-Institutional comparison of robot-assisted laparoscopic versus open ureteroureterostomy in the pediatric population. J Endourol 2015;29:1237-41.