Robotic-assisted laparoscopic surgery: recent advances in urology

Riccardo Autorino, M.D., Ph.D., Homayoun Zargar, M.D., and Jihad H. Kaouk, M.D.

Glickman Urological and Kidney Institute, Cleveland Clinic, Cleveland, Ohio

The aim of the present review is to summarize recent developments in the field of urologic robotic surgery. A nonsystematic literature review was performed to retrieve publications related to robotic surgery in urology and evidence-based critical analysis was conducted by focusing on the literature of the past 5 years. The use of the da Vinci Surgical System, a robotic surgical system, has been implemented for the entire spectrum of extirpative and reconstructive laparoscopic kidney procedures. The robotic approach can be applied for a range of adrenal indications as well as for ureteral diseases, including benign and malignant conditions affecting the proximal, mid, and distal ureter. Current evidence suggests that robotic prostatectomy is associated with less blood loss compared with the open surgery. Besides prostate cancer, robotics has been used for simple prostatectomy in patients with symptomatic benign prostatic hyperplasia. Recent studies suggest that minimally invasive radical cystectomy provides encouraging oncologic outcomes mirroring those reported for open surgery. In recent years, the evolution of robotic surgery has enabled urologic surgeons to perform urinary diversions intracorporeally. Robotic vasectomy reversal and several other robotic andrological applications are being explored. In summary, robotic-assisted surgery is an emerging and safe technology for most urologic operations. The acceptance of robotic prostatectomy during the past decade has paved the way for urologists to explore the entire spectrum of extirpative and reconstructive urologic procedures. Cost remains a significant issue that could be solved by wider dissemination of the technology. (Fertil Steril® 2014;■:■–■. ©2014 by American Society for Reproductive Medicine.)

Key Words: Andrology, indications, robotic surgery, robot-assisted laparoscopy, urology

Discuss: You can discuss this article with its authors and with other ASRM members at http://fertstertforum.com/autorinor-robot-laparoscopic-surgery-urology/

Use your smartphone to scan this QR code and connect to the discussion forum for this article now.*

* Download a free QR code scanner by searching for "QR scanner" in your smartphone's app store or app marketplace.

Robotic-assisted laparoscopy offers unique features compared with standard laparoscopic surgery. EndoWrist instrumentation enhances surgical dexterity and facilitates intracorporeal suturing. In addition, the three-dimensional, high definition, stereoscopic-magnified vision provides an unmatched view of anatomical structures. Overall, robotic technology allows the surgeon to perform complex tasks in a minimally invasive fashion, with a much faster learning curve than laparoscopy (1).

In urology, the application of robotics was initially boosted by the exponential growth of robotic radical prostatectomy (RARP), which in the United States has largely supplanted open surgery as main procedure for prostate cancer (2, 3). In addition, during the past decade, robotics has been increasingly used in numerous other procedures in urology (4, 5). The aim of the present review is to summarize recent developments in the field of urologic robotic surgery.

LITERATURE SEARCH

A nonsystematic literature review was performed using PubMed and Scopus to retrieve publications related to robotic surgery in urology (Fig. 1). In the free-text protocol, the following terms were applied: robotic urologic surgery; robotic kidney surgery; robotic adrenal surgery; robotic ureteral surgery; robotic prostate surgery; robotic bladder surgery; robotic urology. An evidence-based critical analysis was conducted by focusing on the literature of the past 5 years.

UPPER URINARY TRACT

Kidney Surgery

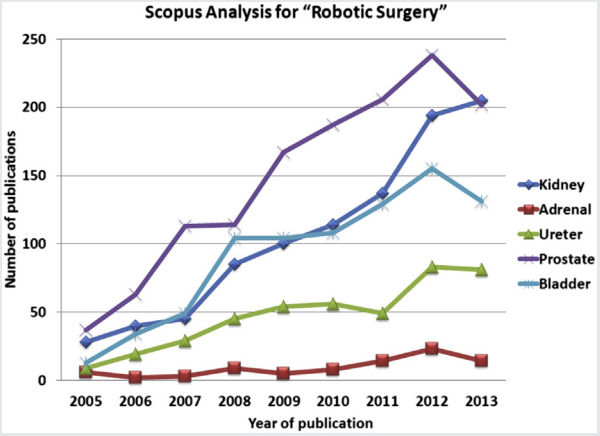
The use of the da Vinci Surgical System robot has been implemented for the entire spectrum of extirpative and reconstructive laparoscopic kidney procedures. Current clinical practice guidelines recommend partial nephrectomy as gold standard treatment for small renal masses (6, 7), given the suggested advantages of nephron-sparing surgery versus radical nephrectomy in terms of renal function preservation and, ultimately, survival (8). Nevertheless, partial nephrectomy remains an underused procedure (9), and this might be related not only to hospital and patient factors (10), but also as a result of the negative impact caused by the introduction of

Received May 5, 2014; revised May 8, 2014; accepted May 21, 2014.
R.A. has nothing to disclose. H.Z. has nothing to disclose. J.H.K. has nothing to disclose.
Reprint requests: Jihad H. Kaouk, M.D., Section of Robotic & Image-guided Surgery, Glickman Urological & Kidney Institute, Cleveland Clinic, 9500 Euclid Avenue, 44195 Q10, Cleveland, Ohio (E-mail: kaoukj@ccf.org).

Fertility and Sterility® Vol. ■, No. ■, ■ 2014 0015-0282/$36.00

http://dx.doi.org/10.1016/j.fertnstert.2014.05.033

FIGURE 1



Organ-based scopus bibliometric assessment of publications related to the field of robotic-assisted urologic surgery.

Autorino. Robotic urologic surgery. Fertil Steril 2014.

laparoscopic radical nephrectomy (11). Recent data suggest that robotic technology may enable surgeons across different practice settings to perform nephron-sparing surgery more frequently (12, 13).

The robotic approach offers the option of a minimally invasive partial nephrectomy, which is likely to recapitulate the safety and effectiveness of the open technique. The standardization of each surgical step has allowed for optimization of the procedure (14) (Fig. 2). In addition, indications for robotic partial nephrectomy have significantly expanded to include more demanding clinical scenarios, such as completely intraparenchymal tumors (15), hilar tumors (16), multiple tumors (17), and patients who have undergone a previous ipsilateral nephron-sparing procedure (18), those with pre-existing chronic kidney disease (19), as well as elderly (20) and obese (21) persons.

Current evidence shows that robotic partial nephrectomy is able to offer a wider range of indications, better operative outcomes, and lower perioperative morbidity than conventional laparoscopic partial nephrectomy (22, 23). In addition, robotic partial nephrectomy seems to be effective in renal function preservation and oncologic control at an intermediate follow-up interval (24). Thus, robotics is likely to supplant laparoscopy as the most common minimally invasive approach for partial nephrectomy whenever the necessary technology is available (25).

FIGURE 2

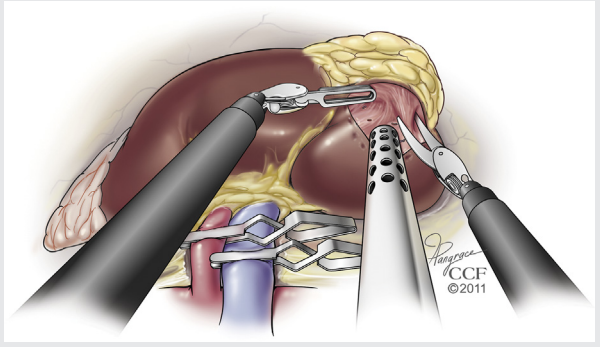


Illustration showing clamped renal hilum and tumor resection using robotic scissors. (Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2010–2012. All Rights Reserved.)

Autorino. Robotic urologic surgery. Fertil Steril 2014.

Laparoscopic radical nephrectomy (RN) is the recommended standard of care for patients with grade T2 kidney tumors and smaller renal masses not treatable by a nephron-sparing approach (26). Long-term outcome data indicate that laparoscopic RN offers equivalent cancer-free survival rates to those of open radical nephrectomy (27, 28). Since the pioneering series of five patients reported by Klingler et al. (29), data in the literature on the use of robotics for RN remain sparse, with all reports being small cases series with limited follow-up. Rogers et al. (30) reported their experience with robotic-assisted nephrectomy for benign and malignant diseases. After a mean follow-up of 15.7 months, there was no local recurrence. Conversion rate decreases with increasing experience of the surgeon. More recently, Dogra et al. (31) confirmed that robotic RN is feasible and safe, with good oncologic outcome on short-term follow-up.

Although the open surgical approach remains the preferred approach in the management of large renal tumors presenting with a thrombus within the vena cava, robotic-assisted surgery may provide the dexterity necessary to allow for the safe application of minimally invasive techniques to such complex clinical scenarios. Abaza (32) reported the first series of robotic RN with inferior vena caval thrombectomy. The inferior vena cava was opened in all five patients, and tumor thrombi were delivered intact, followed by sutured closure. There were no complications, transfusions, or readmissions.

Robotic-assisted surgery has also been adopted by vascular surgeons for procedures where dexterity is required for fine suturing and reconstruction (33). We recently described our technique and show the technical feasibility of robotic-assisted renal artery aneurysm repair (34). The use of the da Vinci Si Surgical System facilitated segmental artery dissection, allowing for selective clamping during reconstruction.

In recent years, robotic nephroureterectomy (NU) has received attention as a viable minimally invasive procedure used in the surgical treatment of upper tract urothelial cancer (35). Robotic NU is very similar to laparoscopic NU, but the extra degrees of freedom and articulation of the robotic wrists make the isolation of the distal ureter and bladder closure less technically challenging. Also, lymph node dissection may be enhanced with the magnified vision of the robotic camera, and the articulation of the wristed instruments can facilitate working in proximity to the great vessels.

Early experience with robotic NU required repositioning of the robot and/or the patient (36). Newer approaches have eliminated the need for patient repositioning or robot redocking (37–39). We recently reported our institution's simplified technique of robotic NU allowing to en bloc resection of the kidney, ureter, and the bladder cuff without patient repositioning or robot redocking (40) (Fig. 3). A key step of the procedure is the management of the bladder cuff. The