



Opinion

Open and robotic radical prostatectomy

Hendrik van Poppel*, Wouter Everaerts, Lorenzo Tosco, Steven Joniau

Department of Urology, University Hospital, K.U. Leuven, Leuven, Belgium

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Abstract Open retropubic radical prostatectomy has been the “gold standard” treatment for locally confined prostate cancer (PCa) but in recent years minimal invasive techniques as laparoscopy and robot-assisted prostatectomy have become widely available. The trifecta of the surgical treatment of PCa is cancer control, the preservation of continence, and erectile potency. Over the years the complication rates of radical prostatectomy have become very limited with improved cancer control and better functional results. We review the indications and the surgical technique of radical prostatectomy, be it open or laparoscopic, eventually robot-assisted as well as the pre- and postoperative measures and the surgery-related consequences.

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1. Introduction

The first surgeries for prostate cancer (PCa) were done more than a century ago, initially through a perineal approach and later through a retropubic approach, which is now the most commonly used open surgical technique for the treatment of locally confined PCa. Reiner and Walsh [1] depicted the anatomy of the dorsal vein complex and the neurovascular bundles in 1979. In 1982, Walsh and Donker [2] described the anatomic nerve-sparing radical prostatectomy (RP), and together with the widespread application of prostate-specific

antigen (PSA) testing, RP became very popular and is in many countries still the gold standard procedure for localized and more recently also for locally advanced and high-risk PCa. In the past decade, several centres have acquired experience with laparoscopic and robot-assisted laparoscopic RP. There are today insufficient data to prove superiority of any surgical approach in terms of oncological outcomes, but the functional outcomes of minimal invasive surgery might be superior while at the same time better tolerated by the patients with less blood loss, less incisional discomfort, shorter length of stay and earlier return to normal daily activities.

2. Patient selection

For many years RP was considered the most efficient treatment for patients with low and intermediate localized PCa (cT1a–cT2b, Gleason score 2–7 and PSA $\leq$ 20 ng/mL)

* Corresponding author.

E-mail address: hendrik.vanpoppel@uzleuven.be (H. van Poppel).

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and life expectancy over 10 years. Moreover, also selected patients with low-volume high-risk localized PCa (cT3a of Gleason score 8–10 or PSA >20 ng/mL) were considered good candidates for surgery [3].

The introduction of active surveillance as a management option for low-risk disease, with low volume, Gleason score 3 + 3, made that today these patients are not anymore treated actively. Instead they are closely followed up and when the disease progresses to become significant (higher Gleason score, higher volume, higher stage) active treatment will still be delivered. More recently, also low volume Gleason 3 + 4 PCa patients can benefit from active surveillance. On the other hand, in recent years RP has become the treatment of choice in selected patients with locally advanced and high-risk localized PCa (cT3b–T4 and 0 or any TN1) in the frame of a multi-modality treatment strategy, certainly in young patients, as mentioned in the EAU-ESTRO-SIOG guidelines [4].

The performance status of the patient and his individual life expectancy are important factors determining the treatment choice. Charlson's comorbidity index, American Society of Anesthesiologists (ASA) score and Frailty index are most in use. Older patients must be carefully selected because of possible comorbidities and complications such as urinary incontinence, but should not be denied RP when this seems curable and high-risk [5,6]. This applies even more in young patients [7].

3. Preoperative measures

Surgery is best performed at least 6 weeks after prostate biopsy and not earlier than 3 months after a transurethral resection since both can cause hematoma, periprostic fibrosis and inflammation that will increase the risk of surgical complications such as neurovascular bundle damage and rectal injury. Whether or not a nerve sparing RP should be decided preoperatively taking into consideration the location, the stage, grade and size of the tumor and the results of digital rectal examination, transrectal ultrasound and multiparametric magnetic resonance imaging (mpMRI). The latter will exactly depict a significant tumor's location, its clinical stage, the proximity of the urethral sphincter or neurovascular bundle and the length of the urethral sphincter. In this way patients can be counseled concerning eventual postoperative urinary incontinence or potency loss. Patients might benefit from pelvic floor exercises before the surgery.

Bowel preparation is obsolete in patients with localized PCa but when embarking on extensive extracapsular disease with seminal vesical invasion, it is safe to give some kind of bowel preparation. For open RP the surgeons use combined spinal–epidural anesthesia that is associated with a reduced intraoperative blood loss [8], a faster recovery and a reduction in the use of analgesics [9]. The epidural catheter can remain in place for patient-controlled analgesia for the first 24–48 h rendering the procedure well tolerated and comfortable for the patient.

4. Surgical procedure

The surgery has been extensively described [10]. Through a midline incision the preperitoneal Retzius space is opened and a lymph node dissection will be performed in men with

intermediate and high-risk PCa encompassing the external iliac nodes, the obturator fossa, the internal iliac and presacral nodes and the common iliac artery up to the crossing of the ureters [11,12].

The endopelvic fascia is then opened and the levator ani muscle dissected. The puboprostatic ligaments are divided and the dorsal vein is controlled with a ligature. The apex of the prostate is dissected and the neurovascular bundles are either preserved and dislocated posteriorly or resected in case of ipsi-lateral extracapsular extension. The urethra is transected at the prostate apical level and the retrograde prostatectomy is continued with either preservation or resection of the neurovascular bundle. The seminal vessels are completely resected and the bladder neck can either be preserved or resected in case of a basal location of the cancer. Once the prostate is removed, the specimen is carefully inspected for capsular incision and an extra resection can be performed when there is doubt about the margin [13]. When the bladder neck was resected a "racket" closure is performed in order to fit the urethral size. Four stitches are enough to anastomose the neo-bladder neck to the urethra.

The surgical details for the resection of locally advanced cancers are obviously different with a broad neurovascular bundle resection at least at the tumor bearing site, and in many cases resection of the bladder neck.

Contraindications for a nerve-sparing procedure are T3b tumors with invasion of seminal vesicles and palpable lesions at the level of the apex [14]. The bladder neck or intraprostatic urethra can usually be preserved in apical T3 tumors [15]. More and more surgeons today report their experience with RP in locally advanced high-risk PCa [5–7,16].

5. Postoperative care

The patient controlled analgesia pump is used for 24–48 h. Patients start with a regular diet as from Day 2. Low molecular weight heparin is continued up to 1 month after the operation. The patient leaves the hospital on Day 5 or 6. If there were no problems the catheter can be removed after a reassuring cystogram or the patient can come back to remove the catheter after 2 weeks. Pelvic floor physiotherapy is started immediately if there is any degree of urinary stress incontinence.

6. Intraoperative complications

The acute complications of open RP are hemorrhage, rectal injury and ureteral injury. Hemorrhage occurs because of inappropriate control of the dorsal vein complex but also because of an attempt to spare the neurovascular bundles. Rectal laceration is uncommon and can occur during apical dissection. When the patient had bowel preparation it can be simply closed and in case of doubt an omentoplasty and anal dilatation can be advised. Ureteral injury can occur during transection of the bladder neck with an intravesical injury to the ureteral ostium. The repair of the bladder neck should then be done after insertion of ureteral catheters.

Deep venous thrombosis and pulmonary embolism must be prevented by low molecular weight heparin started the day before and continued up to 1 month. An anastomotic

leak is exceptional; prolonged lymphatic drainage can occur after extended lymph node dissection; active suction drains in the Retzius space are needed after lymph node dissection. Recto-urethral fistula is uncommon, unless in patients that had previous radiotherapy of rectal surgery and an immediate colostomy is unavoidable. The late complications are anastomotic strictures, which are rare after an adequate bladder neck reconstruction, urinary stress incontinence and erectile dysfunction. Urinary incontinence is for most men the most disabling complication and is very difficult to predict. The reason is damage to the urethral sphincter or its innervation. Patients with shorter sphincters will have more early stress urinary incontinence that will improve with pelvic floor muscle exercises [17,18]. Erectile dysfunction is related to age, preoperative erectile function and the oncologically required degree of resection of one or two neurovascular bundles. After open RP, most patients will suffer a temporary reduced erectile function, but when one or two bundles were spared, reinnervation will take about 8–9 months with further recovery over 2 years, certainly in younger men [19]. A phosphodiesterase-5-inhibitor will help in those that still have some spontaneous erections; those were no remaining erection at all; intracavernous injection therapy gives excellent results. Exceptionally patients will ask for penile prosthesis implants.

7. Oncological results

Increased overall surgical experience obviously results in improved oncological outcome. High volume surgeons gradually diminish their positive surgical margin rates which are related to ultimate cancer control [20].

Open RP provides excellent long-term oncological outcomes for the majority of patients with clinically localized PCa. Studies showed 10-year PSA-free survival rates of >60% and 10-year cancer specific survival (CSS) rates of >94% [21]. Although still controversial, it is increasingly evident that surgery is getting a more and more prominent place as initial treatment for locally advanced and high-risk disease. Some of these patients will be cured with RP monotherapy but many of them will at a certain point in time, need adjuvant or salvage radiotherapy or androgen deprivation therapy. A multi-disciplinary discussion and a multi-modality treatment are keys in decreasing PCa mortality in locally advanced and high-risk disease [6].

Pathological tumor grade and nodal status are significant predictors of biochemical progression, clinical progression-free survival (CPFS) and CSS [22]. Another study showed that biopsy Gleason score is the strongest predictor of progression and mortality. An initial PSA >20 ng/mL associated with biopsy Gleason score ≤ 7 resulted in 10-year PCa-specific mortality (PCSM) of only 5%; when associated with biopsy Gleason score ≥ 8 , PCSM was 35% [23].

8. Robot-assisted laparoscopic RP

The first case series of patients who had undergone laparoscopic prostatectomy was published in the early 1990s by Schuessler et al. [24]. Robotic surgical technology in the early 2000s resulted in a significant progress in the surgical management of PCa. Intuitive Surgical received FDA

approval for the “da Vinci Surgical System” in the year 2000 and the first RP using the system was reported in 2001 [25]. The technique was further refined and has gained widespread acceptance around the world [26,27].

Nowadays 80% of all radical prostatectomies performed in the United States are done with the robotic system [28]. Mostly a transperitoneal approach is done, but an extraperitoneal approach is also feasible [29]. The procedure itself is done under anesthesia in supine and Trendelenburg position. The different trocars are inserted after creation of a pneumo-peritoneum. The robotic arms are then connected to the trocars; the surgeon directs the robotic arms while the assistant manipulates the camera and the other instruments like aspiration and retraction. The technique is extensively described [30].

Different surgeon use different sequencing starting either with the dissection of the seminal vesicles or the apex or the bladder neck; once the prostatectomy is finished, the anastomoses with the robot is much easier than with pure laparoscopy. The freed specimen is placed into an endoscopic retrieval bag and extracted through the supra umbilical wound that needs to be enlarged at this stage.

A typically laparoscopic and robot-assisted laparoscopic surgery results in less blood loss, shortened length of stay (1–2 days) and earlier return to work, and favorable oncologic outcomes, comparable to those obtained in open surgery. The functional outcomes for urinary continence and erectile potency could be better [31,32].

The positive surgical margin rate was compared between open and robot and was the lowest for robotic RP [33]. The biochemical recurrence free survival rates from a cohort study on nearly 5000 men showed 81% at 8 years and a cancer specific survival of 99.1% [34]. These data indicate the effectiveness of robotic RP both from an oncological and functional point of view.

9. Conclusion

Contemporary nerve-sparing open radical retro-pubic prostatectomy remains the standard for patients with localized PCa who can be cured and who have at least a 10-year life expectancy especially in centers where minimal invasive techniques are not available. The increasing experience of surgeons and the better knowledge of the anatomy and refinements in surgical techniques have resulted in excellent oncological outcomes, decreased positive surgical margins, limited operative complications and good functional results. RP is nowadays less frequently performed in low-risk PCa patients and is recommended as initial treatment for locally advanced and high-grade PCa in a multimodal fashion, eventually including adjuvant or salvage radiotherapy, hormone therapy, or a combination of both.

The introduction of robotic surgery has revolutionized PCa surgery. This technology will continue to progress and improve the surgical quality for men with PCa.

Author contributions

Study concept and design: Hendrik van Poppel, Wouter Everaerts, Lorenzo Tosco, Steven Joniau.

Drafting of manuscript: Hendrik van Poppel.

Critical revision of the manuscript: Hendrik van Poppel, Wouter Everaerts, Lorenzo Tosco, Steven Joniau.

Conflicts of interest

The authors declare no conflict of interest.

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