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*The evolution of radical
retropubic prostatectomy
for the management of
clinically localized
prostate cancer over the
past 20 years is reviewed.*

Radical Prostatectomy in the Management of Clinically Localized Prostate Cancer

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Background: Several management options are available when prostate cancer is diagnosed at an early stage. However, the optimal treatment for localized prostate cancer is unknown, and reports in the literature are controversial regarding the best treatment modality for this early presentation.

Methods: The authors review improvements in surgical technique that have decreased complications, and they address long-term outcomes of surgery related to cancer control.

Results: Improvements in surgical techniques allow for decreased intraoperative complications. The incidence of long-term complications such as incontinence and impotency is also reduced. The 5- and 10-year progression-free survival with radical prostatectomy has improved.

Conclusions: Surgery today is safer with improvements in techniques. The long-term outcomes with surgery are excellent and, in several series, better than outcomes achieved with other treatment modalities.

Introduction

Only a decade ago, men diagnosed with prostate cancer presented with advanced disease that was beyond cure. Today, the majority of patients present

with clinically localized disease at the time of diagnosis. Contributing factors include the widespread use of the prostate-specific antigen (PSA) and the availability of transrectal ultrasound to aid in biopsy of the prostate when evaluating an abnormal PSA or digital rectal examination or both. Several management options are available when prostate cancer is diagnosed at an early stage. These options include surgery, radiation therapy (external-beam, brachytherapy, or a combination of both), cryosurgery, or observation. The optimal treatment for localized prostate cancer is unknown, and reports in the literature are controversial regarding the best treatment modality for this early presentation.¹

Any local treatment modality has the potential for complications that might impair the patient's quality

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of life. Surgery presents several possible intraoperative complications such as bleeding that requires transfusion, and postoperative complications such as incontinence, erectile dysfunction, or stricture formation may occur.

This review addresses the most significant improvements in surgical technique that have dramatically decreased these complications. The long-term outcomes of surgery related to cancer control are also addressed.

History

Prior to the 1980s, the surgical anatomy of the prostate was poorly understood. Thus, the surgical technique for radical retropubic prostatectomy was nonstandardized, and the procedure was difficult to perform. High complication rates from intraoperative bleeding and the high incidence of postoperative incontinence, erectile dysfunction, and stricture formation deterred many surgeons from offering surgery as definitive treatment for clinically localized prostate cancer. In 1979, Reiner and Walsh² described the anatomy of the dorsal vein complex and its surgical control. In 1982, Walsh and Donker³ described the anatomic location of the pelvic plexus innervating the corpora cavernosa. These pioneering observations and descriptions of the anatomical basis for radical prostatectomy fostered a resurgence in the use of surgery as treatment for localized prostate cancer and led urologic surgeons to refine the technique within the following two decades. Myers et al⁴ performed anatomical studies of 64 gross specimens and confirmed that the external urinary sphincter extended as a single unit from the proximal penile urethra to the bladder base. The configuration of the external striated urethral sphincter was variable and was related to the shape of the apical prostate. Two prostatic shapes were recognized, distinguished by the presence or absence of an anterior apical notch. This knowledge of the variation in the shape of the prostatic apex helps the surgeon to achieve optimal urethral transection and maximal preservation of the external striated urethral sphincter and other tissues of the continence mechanism. Klein⁵ refined the technique by describing mobilization of the distal third of the prostate with minimal mobilization of the external sphincter, while Poore and colleagues⁶ described the preservation of the prostatic ligaments. A total of 43 men underwent radical retropubic prostatectomy (standard apical dissection in 25 patients and puboprostatic ligament-sparing technique in 18 patients). The median time until continence was achieved after surgery was significantly shorter ($P=.01$) for the puboprostatic ligament-sparing group than for the standard method (6.5

and 12 weeks, respectively). The overall continence rate at 1-year follow-up for the two groups was similar (100% and 94%, respectively). Gomez et al⁷ had previously described the technique for preservation of the bladder neck and its impact on positive surgical margins. The bladder neck was anatomically dissected including the most proximal portion of the prostatic urethra for anastomosis to the urethral stump. This technique did not compromise surgical margins, and they concluded that it may play a role in preservation of continence and that it probably decreased the rate of anastomotic stricture.

In 1998, Hollabaugh and associates⁸ elegantly described the innervation of the external urinary sphincter and the surgical maneuvers required to preserve continence. They mapped the location of the external striated urethral sphincteric branch of the inferior hypogastric plexus and the intrapelvic branch of the pudendal nerve. They found that it was critical to preserve as much as possible of the circumferential muscle fibers of the rhabdosphincter, its fascial attachments, and the autonomic innervation of the smooth muscle and mucosal components and the somatic nerve supply to the rhabdosphincter component of the external striated urethral sphincter. They also described the configuration of the pubourethral ligaments and the precise technique to preserve the anterolateral attachments supporting the urethra. They compared 30 men who underwent the standard radical retropubic prostatectomy with 60 men who underwent the continence-preserving anatomical radical retropubic prostatectomy. While the overall continence rates were similar, preservation of the external striated urethral sphincter and its innervation allowed for a faster return of urinary control after catheter removal. By 1 week, 2-4 weeks, and 9-12 weeks, continence was 65%, 78.3%, and 93.3% in the latter group vs 13.2%, 18.4%, and 44.7% in the former group, respectively.

John et al⁹ recently reported on a technique for seminal vesicle preservation to improve early urinary continence. A standard retropubic radical prostatectomy was performed in 34 patients. A seminal vesicle-sparing radical prostatectomy was performed in a pilot series of 20 consecutive patients. The seminal vesicle tip and surrounding tissue were preserved. In all patients, a modified pad test and posterior urethral sensory threshold test were performed preoperatively at 6 weeks and 6 months postoperatively, and they correlated with urinary continence. In the seminal vesicle-sparing radical prostatectomy group, the continence rate was 60% after 6 weeks and 95% after 6 months. These rates were significantly higher than the continence rates in the standard prostatectomy group (18% and 82% at 6 weeks and 6 months, respectively). The

sensory threshold levels in the seminal vesicle-sparing group were similar to the preoperative values and were significantly lower than the postoperative threshold levels in the standard prostatectomy group.

Klotz and colleagues¹⁰ reported on the use of a cavernous nerve stimulator to map the neurovascular bundles at the time of surgery. Their study concluded that the nerve stimulation led to improved erectile function and that a positive response immediately after removal of the prostate predicted return of erectile function. Other investigators, however, reported no correlation between a positive nerve stimulation response and preservation of potency.^{11,12} Kim et al¹³ reported on the interposition of sural nerve to replace resected cavernous nerves. At 1 year of follow-up, 9 (75%) of 12 potent men who underwent bilateral neurovascular bundle resection and interposition of nerve grafts had return of spontaneous erectile activity. With the incorporation of laparoscopic techniques in urologic surgery, surgeons in Europe have recently described the technique and early outcomes with laparoscopic prostatectomy.^{14,15}

The other major approach to radical prostatectomy is through the transperineal route. Advantages to this technique include less blood loss, better visualization of the bladder-urethral anastomosis, and similar complication rates and cancer control outcomes when compared with the retropubic approach.¹⁶ Scolieri and Resnick¹⁷ recently published a detailed description of the technique as well as surgical and cancer control outcomes using this technique.

Patient Selection

Men with clinically localized disease that is clinically significant and who have a life expectancy of 10 years or greater are candidates to consider surgery as one of the options to manage their cancer. Alternative management options, as well as risks and benefits of the procedure, are discussed with the patient. Potential benefits include long-term reports indicating excellent 10- to 15-year disease-free survival when the cancer is localized, better determination of prognosis with the availability of pathological staging, and the good outcomes with postoperative radiation therapy in the adjuvant or salvage setting.

Surgical Anatomy

A thorough understanding of pelvic anatomy is needed in the performance of this surgical procedure. The pelvic fascia invests the pelvic organs. The pari-

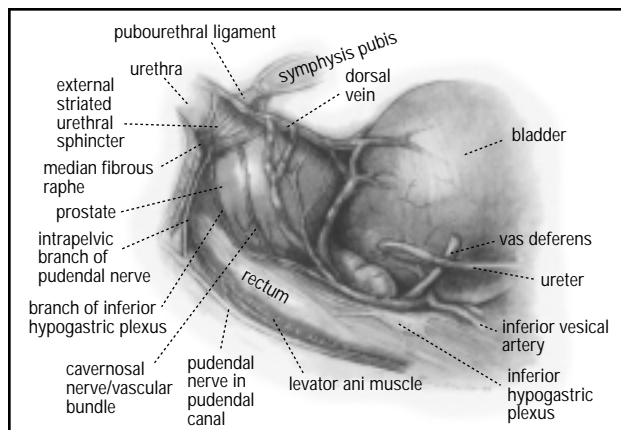


Fig 1. — Sagittal view of the prostate and bladder in the pelvis. The innervation of the mucosal and smooth muscle components is provided via the urethral branch of the inferior hypogastric plexus. From Steiner MS. Continence-preserving anatomical radical retropubic prostatectomy. *Urology*. 2000;55:427-435. ©2000 with permission from Elsevier Science.

etal layer covers the levator muscles, and the visceral layer covers the bladder and prostate. Denonvilliers' fascia covers the posterior surface of the prostate beginning at the apex of the prostate gland. It thickens as it extends cephalad, especially at the level of the seminal vesicles. This fascia separates the prostate from the rectum.

The arterial supply of the prostate arises from the inferior vesical artery. This vessel supplies the base of the bladder, prostate, and seminal vesicles. The prostatic branches of this vessel are located between the parietal and visceral pelvic fascia. The venous drainage arises from the deep dorsal vein of the penis, where it divides into a superficial branch and a right and left lateral venous complex.

The external striated urethral sphincteric complex is composed of the entire circumferential musculature of the rhabdosphincter, the fascial investments (the pubourethral ligaments anterolaterally and median fibrous raphe posteriorly). The innervation of the rhabdosphincter is provided via the intrapelvic branch of the pudendal nerve (somatic), and the innervation of the mucosal and smooth muscle components via the urethral branch of the inferior hypogastric plexus (autonomic) (Fig 1).¹⁸

Surgical Technique

A midline lower abdominal incision is performed. The traditional incision extended from umbilicus to pubis. LaFontaine et al¹⁹ recently reported on a shorter 7- to 8-cm incision providing excellent access and decreased postoperative pain. The pelvic lymph nodes are inspected and palpated but generally not removed

Table 1. — Patient Care Pathways

	Pre-Pathway	Post-Pathway
Total Cost	\$16,000	\$9,200
Length of Stay (days)	7	3.5
NPO (days)	4	1.5
Intravenous Fluids (days)	4	1.5

if the patient is at a low risk of metastasis. The endopelvic fascia is incised at the 3- and 9-o'clock position lateral to the prostate, and a plane is developed cephalad to the apex of the prostate on either side. Control of the dorsal vein complex is then achieved. Different techniques have been described with the intent of obtaining maximal vascular control to minimize bleeding. Damage to the neurovascular bundles and sphincter are also minimized by adequate control of the dorsal vein complex. Koch et al²⁰ recently reported on a transfusion rate of only 2.4% when achieving meticulous control of the dorsal vein complex. The lateral pelvic fascia is then longitudinally incised at the 3- and 9-o'clock position on the surface of the prostate, and the neurovascular bundles are carefully released posterolaterally.

Steiner¹⁸ recently described in detail the “no touch” approach to the sphincter with performance of the dissection proximal to the sphincter to preserve the continence mechanism located at the apex of the prostate. The urethra is then sharply incised and the prostate reflected off the rectum. The prostatic pedicles are controlled with metal clips and transected, further releasing the neurovascular bundles. The seminal vesicles are dissected off the surrounding tissue. Care must be taken not to injure the neurovascular bundle and the innervation to the continence mechanism at this point, as it tends to tent at the tip of the seminal vesicle.⁹ The bladder neck is then excised from the prostate with maximal preservation of this structure. The urethrovesical anastomosis is finally performed, bringing the bladder neck to the urethra with interrupted 2-0 Vicryl. A 22F Foley catheter is left indwelling, and a drain is placed through the abdominal wall close to the anastomosis.

Postoperative Care

By the first postoperative day, the patient should be out of bed, walking, and able to tolerate a regular diet. Most of the patients are discharged on postoperative day 2. The surgical drain is removed the first or second postoperative day, depending on drain output. The catheter is removed 2 weeks thereafter. Little and associates²¹ recently reported on early catheter removal. In a series of 33 patients, 82% underwent successful

catheter removal at a mean of 4.2 postoperative days. Collaborative pathways have been applied to radical prostatectomy. Interventions deemed unnecessary are deleted from the standard postoperative orders, and necessary interventions are standardized.²² Following implementation of this pathway at our institution, the need for prolonged antibiotics and parenteral narcotics is eliminated, which results in shorter hospital stays and lower total costs (Table 1).

Results of Radical Prostatectomy

Catalona et al²³ reported on their series of 1,778 consecutive patients treated by radical prostatectomy from Washington University. The positive margin rate was 21%, 9% had seminal vesicle invasion, and only 2% had nodal metastasis. Pound and associates²⁴ reported on a series of 1,623 men operated on at Johns Hopkins University. Surgical margin status was important only in high-grade tumors. Preservation of potency did not affect cancer control. Zincke et al²⁵ from the Mayo Clinic reported on their series of 3,170 patients. Results of these three series are summarized in Table 2.

D'Amico and colleagues²⁶ compared the PSA outcomes of surgery, external-beam radiation therapy, and brachytherapy. Patients were stratified in low (stage T1c-T2a, PSA level ≤ 10 ng/mL, or Gleason score ≤ 6), intermediate (stage T2b, Gleason score of 7, or PSA level 10-20 ng/mL), or high-risk (stage T2c, PSA level > 20 ng/mL, or Gleason score ≥ 8). The relative risk of PSA failure in low-risk patients treated using either radiation therapy, brachytherapy plus androgen deprivation, or brachytherapy alone was 1.1, 0.5, and 1.1, respectively, compared with patients treated with radical prostatectomy. The relative risk of PSA failure in the intermediate- and high-risk patients treated with implant compared with radical prostatectomy were 3.1 and 3.0, respectively. In this report, the addition of androgen deprivation to brachytherapy did not improve PSA outcome in high-risk patients but resulted in a PSA outcome that was not statistically different compared with the results obtained using radical prostatectomy or radiation therapy in intermediate-risk patients. They

Table 2. — Long-Term Outcomes in Selected Radical Prostatectomy Series

Authors	No. of Patients	Tumor Stage %		PSA Progression-Free Survival:	
		T1	T2	5-yr	10-yr
Catalona et al ²³	1,778	38	60	78	65
Pound et al ²⁴	1,623	38	60	80	68
Zincke et al ²⁵	3,170	7	93	70	52

concluded that low-risk patients had similar 5-year PSA outcomes regardless of treatment. Intermediate- and high-risk patients did better when treated by surgery or external-beam radiation therapy.

Two recent publications compared the PSA outcomes of radical prostatectomy and brachytherapy series. Polascik et al²⁷ reported a 7-year actuarial PSA progression-free survival of 97.8% following radical prostatectomy vs 79% following iodine-125 interstitial radiotherapy. Ramos and colleagues²⁸ reported a mean 7-year recurrence-free survival of 84% for the radical prostatectomy series vs 79% for the iodine-125 brachytherapy series.

Complications

Long-term complications related to radical prostatectomy include incontinence, erectile dysfunction, and stricture formation. The previously discussed improvements in surgical technique have markedly decreased complication rates. Several investigators address the issue of quality of life after local treatment for prostate cancer. They recommend that the evaluation of side effects related to treatment is performed with validated questionnaire instruments.^{29,30}

Erectile Dysfunction

Stanford et al³¹ recently reported on continence and potency outcomes derived from the Prostate Cancer Outcomes Study (PCOS), a large community-based cohort of patients following radical prostatectomy. Patients resided in various geographic locations, and thus a large number of surgeons were involved. A total of 11,137 patients were identified, and 4,736 were contacted to participate. A total of 3,533 patients (62.3%) responded to the survey at 6 and 12 months. Age range was 39 to 79 years of age. At 18 months, 59.9% of patients were impotent and 41.9% of patients reported that their sexual performance was a moderate to large problem. Walsh and associates³² reported simultaneously on their outcomes at a center where several of the modern radical prostatectomy techniques were developed and improved. A validated disease-targeted quality-of-life survey that assessed function and bother in two organ systems (urinary and sexual) was administered preoperatively and at 3, 6, 12, and 18 months postoperatively to 64 men with localized prostate cancer who were potent preoperatively. Potency, defined as the ability to have unassisted intercourse with or without the use of sildenafil, improved gradually, and by 18 months, 86% of patients were potent and 84% considered sexual bother as none or small.

In a retrospective review of our surgical series by one surgeon, 717 radical prostatectomies were performed from February 1988 to June 2001. A review of our early experience with the first 229 patients from 1988 to 1996, using several of the previously described techniques, found that similar outcomes were achieved. Potency was preserved in 69% of the patients overall. Potency preservation was achieved in 80% of men younger than 59 years of age, in 77% of men between 60-69 years of age, but in only 34% of men older than age 70.³³

Urinary Incontinence

A report by Stanford et al³¹ noted that 8.9% of patients were incontinent for 18 months. Walsh and colleagues³² reported that urinary continence (no pads) gradually improved during the first 12 months after surgery, and at 12 and 18 months, 93% of the patients were dry. Only 1% of patients developed urinary leakage requiring surgical intervention. In our institutional series of 229 patients noted above, continence was achieved in 92% of the patients. Age was again a strong predictor of outcome. Only 5% of men age 69 years or younger had incontinence vs 31% for men age 70 or older.

Laparoscopic Radical Prostatectomy

Guillonnet et al¹⁴ reported their updated results with radical prostatectomies performed by transperitoneal laparoscopy. A total of 350 consecutive patients underwent laparoscopic radical prostatectomy. No deaths were observed. Conversion was required in seven cases, exclusively among the first 70 patients. The mean operating time was 217 ± 59 minutes, including lymphadenectomy, which was performed in 21.4% of patients. The operating time for the last 200 patients was 195 ± 56 minutes. The mean intraoperative blood loss was 354 ± 250 mL. The overall transfusion rate was 5.7% and 2.8% in the last 250 patients. Intraoperative complications were reported in 14 patients (4%), and the reoperation rate was 3.7%. The mean postoperative bladder catheterization time was 5.8 ± 3.3 days, and the catheter could be removed before day 5 in 41% of patients. The mean hospital stay was 6 ± 3.9 postoperative days (range 2-33 days). Continence rate (no protection necessary either during the day or at night) among the first 133 patients was 85.5%, and the postoperative erection rate was 59% among 22 selected consecutive patients. Abbou and colleagues¹⁵ presented results on 43 patients undergoing laparoscopic radical prostatectomy. Mean operating room time was over 4 hours. One patient sustained rectal injury requiring

colostomy, and 4 patients developed anastomotic leak. A total of 84% of the patients were fully continent at 1 month. The positive margin rate was 27%. In both of these series, the authors claim that laparoscopy permitted superior visibility in defining the external urethral sphincter and neurovascular bundles.

The technique consists of achieving laparoscopic access via five ports (Fig 2). Following incision of the lower peritoneal arch, posterior dissection is performed allowing access to the seminal vesicles and vas deferens. The urachus is divided and the anterior space is created exposing the apex of the prostate. The dorsal vein complex is ligated and the bladder neck is dissected off the prostate. The pedicles are taken down in an antegrade fashion, sparing the neurovascular bundles, and the prostatectomy is completed. The bladder-urethra anastomosis is performed, and finally, the prostate is removed through one of the laparoscopic ports.

Raboy et al³⁴ recently reported on an extraperitoneal laparoscopic approach in two patients with the potential advantage of not having to enter the peritoneum. Complete endoscopic removal of the prostate and seminal vesicles was achieved in both patients. Endoscopic reconstruction of the bladder neck with watertight anastomosis was successful in both. Operative time and estimated blood loss improved from 5 hours 45 minutes and 600 mL, respectively, in patient 1

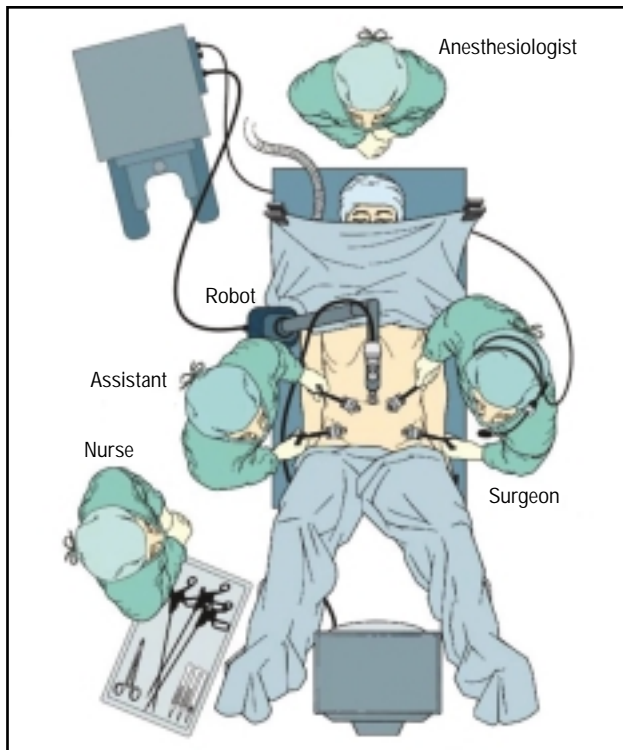


Fig 2. — Laparoscopic radical prostatectomy consists of achieving laparoscopic access via five ports. From Krongrad A. Radical prostatectomy. *Urol Pan.* 2001;13. Reprinted with permission.

to 4 hours and 400 mL in patient 2. The hospital stay was 2.5 days for both patients.

We recently performed radical retropubic prostatectomy through a smaller incision than the usual incision of 8-10 cm. A suprapubic midline 5-cm incision was performed and visualization was assisted by a laparoscopic port (Fig 3). Conventional operating instruments were used through the incision, and the standard steps for anatomic radical prostatectomy were followed. Ten patients with clinically localized prostate cancer were operated on with this approach. The mean body mass index was 24.1. The mean operating room time was 259 minutes. The mean estimated blood loss was 1,594 mL,

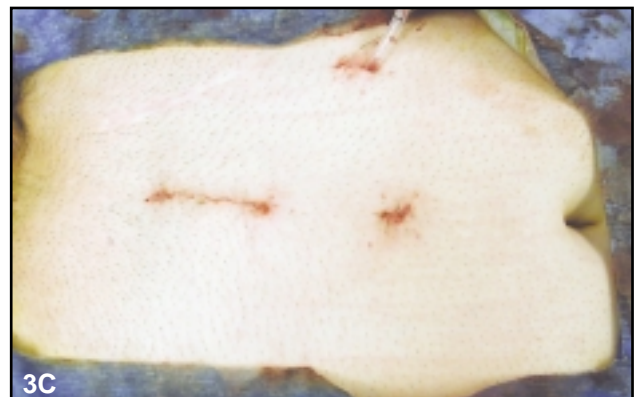
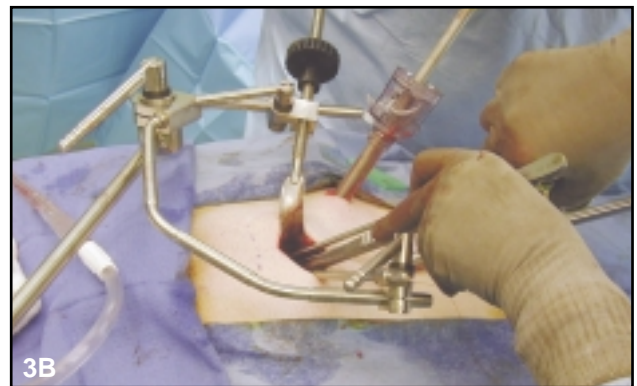


Fig 3. — (A) 5-cm incision in suprapubic area, (B) laparoscope in place with surgery performed through the 5-cm incision, and (C) procedure completed, with closed incision and drain.

and the mean postoperative morphine sulfate requirement was 2.1 mg. Two patients required conversion to a standard open procedure due to technical difficulties. The positive margin rate was 10%. A total of 88% of patients were fully continent at 1 year. Eight patients were potent preoperatively, and 6 (75%) of these patients are potent 1 year after surgery either spontaneously or with the aid of sildenafil sulfate. Potential advantages of this approach include the magnification provided by the laparoscope and the minimal incision needed for the use of standard operating instruments with a potential for faster postoperative recovery.

Conclusions

Surgical techniques have been developed in the last 20 years with the intent of decreasing complications associated with surgical removal of the prostate. The long-term outcomes with surgery are excellent and, in several series, better than the outcomes achieved with other treatment modalities.

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