Prostatectomy for benign prostate disease: open, laparoscopic and robotic techniques

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Introduction: *Prostatectomy for benign disease, also known as a 'simple prostatectomy', is neither simple in indication nor approach. In the post-Medical Therapy of Prostatic Symptoms (MTOPS), NCT00021814 trial era, the medical management of benign prostatic hyperplasia (BPH) and consequent bladder outlet obstruction (BOO) has shifted surgical intervention to those patients who are medical-non responders, present with advanced signs of BOO and obstructive uropathy, and those with prostate gland volumes beyond the size normally approachable with standard transurethral resection of the prostate (TURP). Simple prostatectomy through an open surgical approach is associated with improvements in BOO and lower urinary tract symptoms (LUTS) but at the expense of considerable surgical and perioperative morbidity. Advances in technology have made it possible for patients to be offered standard open surgical approaches as well as transurethral approaches with photon-based energy sources (i.e. laser prostatectomy) and laparoscopic simple prostatectomy. A review of the historical challenges of BPH and the standard-of-care of open prostatectomy will put into perspective the potential advantages and disadvantages of laparoscopic and robotic prostatectomy for the treatment of benign BOO due to BPH.*

Materials and methods: *A careful review of the literature was performed utilizing PubMed and ClinicalKey searches to identify relevant articles. Search terms "simple prostatectomy", "robotic simple prostatectomy", and "laparoscopic simple prostatectomy".*

Results: *Over 14 series of open simple prostatectomies and over 20 minimally invasive series were identified and used as a reference. Additionally, several review articles were identified and incorporated.*

Conclusions: *Simple prostatectomy may be performed safely in appropriately selected patients utilizing either open or minimally invasive approaches. Clinical criteria should be used to determine the appropriateness of either retropubic versus transvesical approach.*

Key Words: prostatectomy, prostatic adenoma, benign prostatic hypertrophy, robotic surgical procedures, laparoscopic surgery

Historical approaches

Benign prostatic hyperplasia (BPH) is the most common benign tumor among men.[1] While many effective therapies exist for men with mild symptoms and smaller prostate glands, simple prostatectomy remains the gold standard for patients with severe symptoms and prostates larger than 80 grams. Indications for simple prostatectomy include urinary retention requiring catheterization, bothersome lower urinary tract symptoms (LUTS) refractory to medical therapy, inadequate emptying demonstrated by elevated post void residual, frequent urinary tract infections secondary to BPH, severe hematuria secondary to prostatic bleeding, bladder calculi, or chronic kidney disease secondary to prostatic enlargement. Open simple prostatectomy may be preferred over transurethral resection of the prostate (TURP) with prostates larger than 80 g, concomitant surgically-amenable bladder conditions, planned concomitant hernia repair, and patients in whom ankylotic disease of the hip prevents the lithotomy position.[2]

Historically, 12%-15.5% of patients receiving TURP require further surgery, while only 1.8%-4.5% of those treated with open surgery underwent

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re-operation within 8 years.[3] For prostates > 80 g, TURP was associated with morbidity rates of 55% and mortality rates of 6%, while the open prostatectomy had mortality rates of 3.3%.[4,5] Today, mortality rates from both procedures approach 0%.[2,6] Furthermore, modern techniques, such as holmium laser enucleation of the prostate (HoLEP) and KTP laser have produced favorable results in large prostates.[7-9] However, drawbacks to this option include cost, steep learning curve, specialized equipment, prolonged urethral instrumentation with associated urethral complications, and the need to morcellate laser-resected tissue free-floating in the bladder. Disadvantages of the open prostatectomy include need for extraperitoneal incision, bleeding requiring transfusion, sphincteric, neurovascular bundle, or rectal injury, prolonged hospital stays, and increased catheterization time.[10]

Suprapubic (transvesical) and retropubic approaches to simple prostatectomy have been described with each offering distinct advantages. First performed in 1894 by Eugene Fuller, and popularized by Peter Freyer in 1900 and Robert Proust in the early 1910s, the suprapubic prostatectomy involves resection of the prostatic adenoma via cystotomy. Transvesically, the urologist is able to treat concomitant bladder pathology via direct access to the bladder at the time of adenomectomy and may therefore be preferred over the retropubic approach when bladder calculi, large median prostatic lobes or bladder diverticula are present.

Terrence Millin saw that the cystotomy may add undue morbidity to the procedure and was unable to provide visualization of the distal adenoma and sphincter, so he proposed a purely retropubic approach for more control over the prostatic apex during enucleation to avoid traction injury to the urethral sphincter as well as more adequate prostatic exposure at the expense of bladder accessibility.[2,11]

Advent of laparoscopic prostatectomy

The open surgical approach remained the gold standard for 100 years, Table 1. A major change came with the advent of laparoscopic radical prostatectomy, first performed by Schuessler in 1991, and refined by Bertrand Guillonneau, Guy Vallencien, and Claude Abbou throughout the late 1990s. These pioneering surgeons found that the laparoscopic approach to the prostate could minimize the invasiveness and morbidity commonly associated with the retropubic open approach involved in the procedure. Guillonneau, experienced in laparoscopic sewing in the deep pelvis with gynecologic pelvic floor re-suspension techniques, noted that a primary approach to the prostate by exposure of the retrovesical seminal vesicles and vasa deferens could alleviate the limitations found in Schuessler's purely retropubic adaptation of Walsh. In 2002, Guillonneau

TABLE 1. **Open prostatectomy series**

Author	Approach (n)	Complication rates	Bladder neck contractures	Re-operation	Mortality	Transfusion	Hospital stay*	Catheter use*
Varkarakis et al[40] 2004	Suprapubic (151)	13%	3%	3.90%	0%	6.80%	6	5
Serratta et al[6] 2002	Both (1804)	37%	5%	3.60%	0.055%	8.20%	6.9	5.5
Tubaro et al[39] 2001	Suprapubic (32)	31%	6%	0%	0%		6.2	5.4
Adam et al[10] 2004	Retropubic (201)	22%	0%	4%	0	18.90%	10	6.4
Condie et al[32] 1999	Suprapubic (200)	14%	1%	1%	1%	1.00%	6.2	-
Meier et al[11] 1995	Suprapubic (240)	20%	2%	2.90%	0%	4.60%	9	7
Totals	**n = 2628**	**23.0 +/- 0.1%**	**3.0 +/- 0.2%**	**3.0 +/- 0.0%**	**0%**	**7.9 +/- 0.1%**	**7.4 +/- 1.7**	**5.9 +/- 0.8**

*days

TABLE 2. **Minimally invasive comparative studies**

Author	Comparison	N	Method	Findings
Baumert et al[15] 2006	Open vs. Lap	60	Retrospective (30 lap vs. 30 open) for prostates > 80 g	No significant difference in incidence or severity of complications or perioperative functional results
Porpiglia et al[38] 2006	Open vs. Lap	40	Prospective RCT (20 vs. 20)	Extraperitoneal laparoscopic simple prostatectomy provides results comparative to open, with the advantage of significantly lower blood loss
Parsons et al[37] 2015	Open vs. MISP	6220	6027 (OSP) vs. 193 (MISP)	Overall MISP and OSP showed no significant difference between each other
Lucca et al[34] 2015	Open vs. MISP	764 MISP	Meta-analysis (27 studies with 764 total MISP)	MISP offers similar improvement in Qmax and IPSS as OSP. While taking longer, it results in less blood loss and shorter hospital stay

Lap = laparoscopic; OSP = open simple prostatectomy; MISP = minimally invasive simple prostatectomy

reported the feasibility, low perioperative morbidity and encouraging oncologic results of the procedure in 550 patients.[12] During neurovascular bundle release and dissection of the posterior bladder neck, it was noted that subcapsular dissection of the adenoma was possible. Mariano is generally regarded as the first surgeon to intentionally course along the retro-adenomatous plane to deliver obstructing adenomas and achieve a pure laparoscopic simple prostatectomy of a 173 gram prostate.[13,14] Reported advantages over the open approach included improved visualization of the adenoma, venous tamponade due to pneumoperitoneum during dissection, and the avoidance of a major lower abdominal incision. Disadvantages were the mechanical challenge in laparoscopic manipulation of very large adenomas, steep learning curve, and complex suturing required in capsule plication and advancing the bladder neck,[15,16] Table 2.

Robotic prostatectomy

Robotic prostatectomy greatly alleviated the burdens of laparoscopic techniques for cancer surgery and made the procedure more accessible. As applicability of robotics to cancer surgery grew, robotics was also considered for benign surgery. Sotelo et al are regarded as the first group to robotically perform a simple prostatectomy in 2008, attempted after years of laparoscopic experience.[17] Robotic surgery offers the theoretical advantage over laparoscopy of a faster learning curve, especially regarding suture techniques, with the presumably shared benefits of laparoscopy including less perioperative morbidity, improved visibility and precision, faster recovery and ability to demonstrate technique and disseminate skills via the sharing of surgical videos on the internet. Disadvantages of the robotic approach include cost of the device and invasiveness of the procedure.[18]

Variations of the robotic approach include the extraperitoneal approach espoused by Joseph et al adapting the Heilbron technique used for radical prostatectomy which affords equal visualization without the problems of transabdominal surgery in an older surgical population.[19-21] Joseph found that additional advantages of an extraperitoneal approach was the compartmentalization of any urinoma or hematoma, decreased rates of non-obstructive ileus, and decreased rates of early narcotic-dependent pain scores in those with ASA scores of 1-3. Clavijo et al proposed an intrafascial approach in which complete prostatectomy is performed, hoping to reduce blood loss and eliminate the amount of residual prostatic tissue that might be a harbinger for future malignancy in the event that cancer is found in the surgical specimen.[22] Potential drawbacks to this approach include the need to manipulate the neurovascular bundles and urethra more than standard approaches with the theoretical risk of stress incontinence and impotence rates similar to radical prostatectomy techniques.

Technical

Incision

The open approach has been described in essentially unchanged form since 1887.[23] Some surgeons including J. C. B. Marion in early 20th century Paris are said to have completed the procedure 'skin-to-skin' in 15 minutes. In 5°-10° Trendelenburg position, the patient's lower

abdomen and pelvic region are prepped, an 18 French Foley catheter is inserted into the bladder, and 5000 Units subcutaneous heparin are administered. Either a midline infra-umbilical or Pfannenstiel incision is made. A Balfour retractor is sufficient for exposure. The space of Retzius is entered and the posterior rectus abdominis fascia is incised above the semicircular line to the level of the umbilicus sometimes facilitated by the blunt separation of the peritoneum from the vasa deferens as espoused by Skinner et al. The inferior epigastric arteries should be elevated anteriorly when in the correct plane and should be avoided. When a transverse incision is performed, the superior flaps of rectus fascia are grasped on either side of the midline using Kocher clamps. The rectus bellies are divided in the midline using a mixture of blunt and electrocautery dissection to divide the transversalis fascia.[24,25]

Retropubic versus suprapubic

For the retropubic approach, bilateral endopelvic fasciotomies may be performed to identify the prostatic base. Hemostatic maneuvers can include a 2-0 figure-of-eight suture ligature of the prostatic pedicle with a UR-6 needle and sequential ligature of the dorsal venous complex with a V-lok suture after division of the puboprostatic ligaments. A transverse incision is then made over the prostatic capsule and a Metzenbaum scissor is used to dissect down to the adenoma. Capsular flaps are raised to expose more capsule. Venous bleeding should be tolerated at this time with aspiration and without further hemostatic maneuvers.

For the suprapubic approach, the space of Retzius is left undisturbed but the bladder instilled with 200 cc of NaCl sterile irrigant before clamping the Foley. No hemostatic maneuvers of the DVC or prostatic pedicle are performed. A transverse cystotomy is performed between 2-O or 3-O synthetic absorbable suture (e.g. Vicryl). The bladder may now be thoroughly inspected for calculi or diverticula. The ureteral orifices are identified and care is taken to avoid them; or they may be intubated with pediatric feeding tubes for confirmation. A circumferential incision is made on the bladder epithelium distal to the trigone to surround the adenoma and create a plane for the final, most proximal portion of the resection.

Adenomectomy

Resection of the adenoma begins by insertion of the surgeon's index finger between the capsule and adenoma. In the retropubic approach, this begins anteriorly and then laterally. For the transvesical approach, the anterior attachments to the capsule, the median 'commissure', are bluntly broken with anterolateral pressure directed toward the adenoma. Next, forceful but slow, deliberate blunt dissection is used with the tip of the index finger to peel adenoma off of surrounding prostatic capsule. At the apex, care is taken to avoid traction injury on the external sphincter which generally is better visualized from the retropubic capsulotomy approach.[24,25] Where critical, the suprapubic approach can be extended inferiorly by dividing in the midline from the sub-trigonal incision along the anterior capsule to perform a 'suprapubic/retropubic approach'. To avoid distraction injury to the sphincteric complex, a pinching mechanism with two fingers is used to stabilize the apical prostate while more proximally the dissection is carried out and the adenoma is resected away from area of concern. At the most distal end of the adenoma, near the membranous urethra, sharp dissection with Metzenbaum scissors may be used to complete the enucleation.

Hemostatic maneuvers

The fossa is then packed to allow for capsular contraction. A figure-of-eight stitch at the 5 o'clock and 7 o'clock positions of the bladder neck along with plication and advancement of the bladder neck into the prostatic capsule is performed. Once hemostasis is ensured, the Foley is placed back into the bladder and 20 cc of sterile water are inserted into the 30 cc balloon. With the transvesical approach, placement of a suprapubic tube is recommended.[26]

Limitations

Limitations of the open approach include the somewhat blind dissection of the adenoma and the inability to truly visualize the distal extent of the adenomatous lobes as they approach the sphincter. Plication of the bladder neck is a mere suturing of the bladder neck down to the raw surface of the posterior prostatic capsule without surgically addressing the divided urethra itself. Hemostasis is often sub-optimal and after venous pressures and patient valsalva has been restored in the recovery room, initially clear urine may quickly become bloody.

Laparoscopic and robotic approach

Port placement

The laparoscopic simple prostatectomy begins with placement of five trocars either transperitoneally or extra-peritoneally.[13,27] The extraperitoneal approach involves making a 12 mm infraumbilical incision and dissecting down to the anterior rectus fascia. This fascia is incised transversely and the bellies of the rectus are

separated bluntly in the midline. Finger dissection inferiorly is carried out in the preperitoneal space, taking care to avoid incidental peritonotomy by applying anterior pressure inferiorly when the posterior rectus fascia disappears below the arcuate line. A 12 mm balloon dissector with 10 mm visual optical channel is inserted and directed inferiorly toward the pubis and into the developed preperitoneal space. The balloon is slowly inflated under direct visualization. In the correct plane, the inferior epigastric vessels remain visible ventrally. The balloon is deflated and the balloon trocar is inserted, a 0-degree optical lens is inserted, and the space is filled with 10 to 15mm Hg of CO2. Four additional trocars are inserted under direct vision with two 5 mm trocars close to the anterior superior iliac spines and two 10 mm trocars lateral to the rectus and 5 cm-10 cm below the umbilicus.

Planes of dissection

Manual inspection of the bladder and prostate is replaced by visual landmarks. Deformation of the 'shoulders' of the prostate can be appreciated, but may be challenging with large prostates. Instead, careful manipulation of the bladder, filled with 200 cc NaCl, may be required to identify the transition to firm prostatic lobes from the softer bladder wall. After transverse cystotomy, the large adenoma is immediately encountered. A CT-1 suture is often required through an un-tied figure-of-eight, clipped with a large Weck clip to allow for anterior elevation of the median lobe or of the bladder lumen by the assistant. Dissection of the adenoma is carried out through a transverse incision distal to the trigone and coursing inferiorly rather than inferioposterioly as would be done in a radical prostatectomy. The bladder neck is well-perfused and bleeding will be encountered requiring suction and posterior traction by the assistant. The correct plane can be identified by leaving posteriorly the transverse fibers of the prostatic capsule and elevating the smooth borders of the adenoma out of the fossa. Once freed posteriorly the surgeon courses laterally to identify the lateral lobes. Robotically, the Prograsp dissector greatly facilitates adenoma manipulation and monopolar scissors, with their 270° of freedom, may ease both dissection and coagulation as the adenoma is freed from the capsule. In excessively large prostates, it may be required to resect the median lobe prior to dissecting the lateral lobes. The anterior plane is then approached and followed caudally. Sharp dissection should occur across the urethra to encounter the Foley which is withdrawn. The adenoma is resected free and placed into a specimen bag.

Hemostatic maneuvers and bladder plication

Once the adenoma is removed, the pneumoperitoneum permits a clear field to inspect for arterial capsule bleeders, often amenable to fulguration. Bleeders from the bladder neck, derived from the intravesical pedicle, require V-lok hemostastic ligation or placement of M-knots with a 3-0 vicryl on an RB1 needle. Plication of the bladder neck over the posterior capsule is then performed in an interrupted fashion using 2-0 monocryl on an RB1, ensuring that the Foley catheter easily passes from the urethra into the bladder. Formal urethrovescial anastomosis has been proposed, at least posteriorly, to ensure apposition of the bladder neck to urethral mucosa thereby aiding in hemostasis and purportedly decreasing bladder neck contracture rates.[16,28] Once the adenomas are resected, the visual field, the ease of suture placement, and the plication of the bladder neck tightly to the prostatic capsule are greatly improved with robotic technology.[29]

Retropubic approach

The retropubic approach has been described utilizing transverse anterior prostatic, longitudinal anterior prostatic incisions, longitudinal prostatovesical and transverse incision just proximal to the prostatovesical junction. Sotelo et al recommends the transverse incision just proximal to the prostatovesical junction to avoid disruption of the venous plexus and recommends resection of adenoma as separate lobes for improved visualization. Finger dissection through a modified suprapubic hand port improves speed of resection and permits timely hemostatic control.[30]

Anastomosis of the bladder neck distally to the severed urethra is often limited by the presence of the posterior prostatic capsule which is still contiguous with the posterior detrusor fibers as they course inferolaterally. The long term outcomes of vesicourethral anastomosis are yet to be determined especially in those patients who require adjuvant radiation therapy to the prostatic capsule after the identification of clinically significant incidental adenocarcinoma within the surgical specimen.

Clavijo et al describe an intrafascial technique in which they perform a complete prostatectomy, preserving the seminal vesicles, periprostatic fascia and and puboprostatic ligaments, while the prostate in its entirety is dissected free.[22] The lateral prostatic pedicles and anterior prostatic veins are first ligated with the latter suture serving as a traction suture during mobilization and dissection of the prostate. The endopelvic fascia is incised ventrally, medial to the puboprostatic ligaments, but high along the lateral prostate surface to allow the neurovascular bundles

to be released. The incision is taken to the apex of the prostate and the dorsal vein complex is transected and suture ligated. The endopelvic fascia and neurovascular bundle are then peeled off of the prostate using sharp dissection in a retrograde fashion. The urethra is transected as far proximally as dissection permits to maximize urethral length. The seminal vesicles are transected at the prostate base and specimen removed. Remaining seminal vesicles and vas deferens are oversewn and closed. A vesicourethral anastomosis is performed in a manner similar to that of robotic prostatectomy. The residual anterior prostatic fascia is then sutured to the anterior bladder wall.

Complications

Patient selection and surgical planning is important and should involve a thorough cardiovascular workup. Incontinence, bleeding and cardiac complications account for much of the morbidity and mortality. Patients undergoing surgical planning for BPH should be screened for prostate cancer as rates of incidental prostate cancer can be found in 6%-10% of specimens in larger series.[31-41]

Conclusions

Simple prostatectomy may be performed safely and effectively via several approaches. Therefore, differences in outcomes must reach a certain threshold of clinical significance if patients are to be referred long distances or new technology purchased. As outcomes increasingly focus on the costs of recovery, robotic simple prostatectomy may become more attractive by decreasing hospital stay and reoperation results. 'Simple' prostatectomy may never be simple, but the ultimate outcome of improved LUTS and adequate bladder emptying, are simple goals requiring persistent efforts to achieve while minimizing cost and complications.

Disclosure

Dr. Mark Ferretti and Dr. John Phillips have no disclosures. □

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