Monique Gueudet-Bornstein. *James Andrews, Shorty Trombone.* New Orleans 1999.

With outcomes similar to those achieved with the open approach, laparoscopic radical prostatectomy is a promising treatment option in managing localized prostate cancer.

Pure Laparoscopic and Robotic-Assisted Laparoscopic Radical Prostatectomy in the Management of Prostate Cancer

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Background: *Until recently, open radical prostatectomy was the only approach for the surgical management of prostate cancer. Laparoscopy is now increasingly used as an alternative approach. The procedure can be performed directly or with robot assistance.*

Methods: *We review the relevant literature regarding oncologic and functional outcomes with laparoscopic surgery in the management of localized prostate cancer.*

Results: *Oncologic and functional outcomes are similar between open and laparoscopic radical prostatectomy. Pure laparoscopic prostatectomy and robotic assisted laparoscopic prostatectomy result in less blood loss and shorter convalescence. Costs associated with the initial investment, disposables, and maintenance of the robot system are higher than for pure laparoscopic prostatectomy.*

Conclusions: *Laparoscopic radical prostatectomy, either pure or robotic, is becoming the preferred approach for the surgical management of localized prostate cancer. Oncologic and functional outcomes are similar to the open approach.*

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Introduction

The surgical management of localized prostate cancer continues to improve due to refinements in techniques, better understanding of anatomical landmarks, and newer technologies. Only a decade ago, experienced laparoscopic surgeons in the United States considered laparoscopy as not an effective approach for the surgical management of localized prostate cancer.[1] At the same time, European surgeons began reporting on their initial promising outcomes with the laparoscopic approach.[2] Herein, we review the progress in laparoscopic surgery in the management of localized prostate cancer. We discuss our technique and our initial intraoperative and immediate oncologic outcomes with this procedure.

Historical Perspective

Laparoscopic radical prostatectomy was first reported by Schuessler et al[1] in 1997. They concluded that the procedure was feasible but cumbersome and did not offer any advantage over the open approach. In 1999, Guillonneau et al[2] from France reported on their initial series of 40 patients with the laparoscopic approach. Their median operative time was 270 minutes and the positive margin rate was 17.5%. Five patients required conversion to open surgery, and 1 patient had a rectal injury. The procedure was rapidly adopted in Europe over the following years, while in the United States few centers considered this approach.[3-5]

Binder and Kramer[6] of the United Kingdom reported on the first robotic-assisted laparoscopic radical prostatectomy. In 2002, Menon et al[7] reported their initial experience at Henry Ford Hospital with the use of the DaVinci robot (Intuitive Surgical, Inc, Sunnyvale, Calif) after its approval for clinical use in laparoscopic prostatectomy. In 2007, most laparoscopic prostatectomies are performed robotically in the United States, while in Europe and the rest of the world the procedure was performed by a pure approach. Still, more than half of the prostatectomies are performed through an open approach in the United States and worldwide.

Surgical Technique

The procedure can be performed using either a transperitoneal or direct extraperitoneal approach. A recent study comparing the two approaches reported that there was no difference in blood loss, rate of positive margins, or complications. However, operative time was shorter with the extraperitoneal approach.[8]

At our institute, we perform the procedure through a pure laparoscopic, extraperitoneal approach. Our procedure incorporates technologies that provide similar functions offered by the DaVinci robot, such as 3-dimensional (3-D) vision (Viking Systems, Inc, San Diego, Calif) and articulating instruments (Cambridge Endoscopic Devices, Inc, Framingham, Mass). Additionally, the procedure incorporates a high-pressure water dissector (ERBE USA, Inc, Marietta, Ga) that offers the potential for better nerve preservation. Our procedure allows for modular incorporation of these and newer technologies as they become available.

To provide 3-D vision during the procedure, the surgeon wears goggles mounted on a headset. The LCD display allows the surgeon to view picture-in-picture imaging information such as the patient's ultrasound studies.[9] These studies can be correlated with the surgical anatomy and can assist the surgeon in navigating the surgical field. The assistants also wear headsets and are able to see the same 3-D images (Figs 1A–B). Handheld articulating instruments allow for 7 degrees of freedom for accurate placement of sutures when needed while preserving tactile (haptic) perception (Figs 2A–C).

A 2-cm mid-line incision is performed 1 to 3 cm caudad to umbilicus. The incision is carried down between the rectus muscles into the prevesical, extraperitoneal space. The space is developed with finger and balloon dilation. Four to five trocars are placed in the lower abdomen (Fig 3). The first is a 12-mm trocar and is placed below the umbilicus. The second and third trocars are located approximately 10 cm lateral and 3 cm below the first trocar and lateral to the rectus muscle. Care must be taken not to puncture the hypogastric vessels. A fourth 5-mm trocar is placed above and medial to the right anterior iliac crest and used for the assistant to pro-

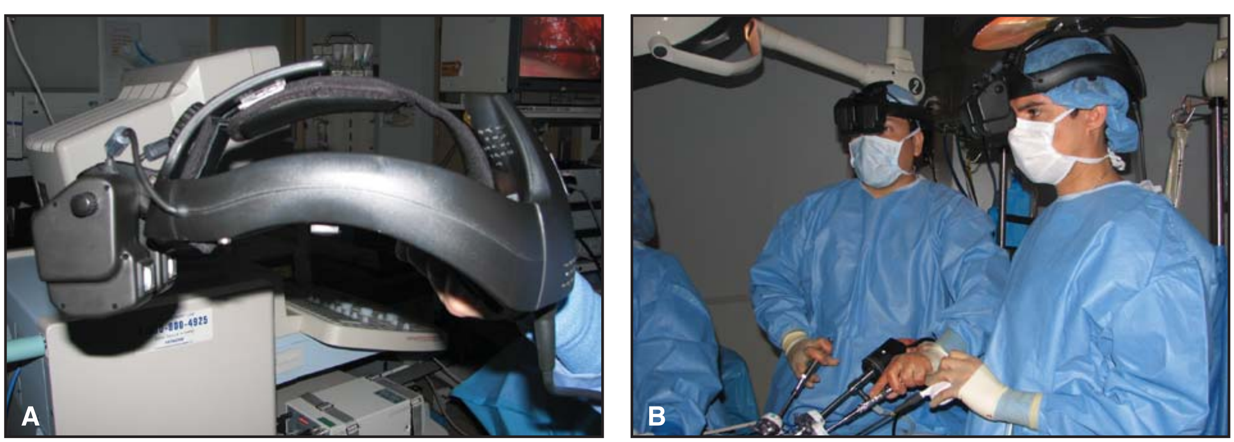

Fig 1A-B. — (A) Three-dimensional vision headset. (B) Surgeon and assistant viewing surgical field through LCD displays in headset.

Fig 2A-C. — (A) Tip of handheld articulating needle holder with 7 degrees of freedom. Photo courtesy of Cambridge Endoscopic Devices, Inc. (B) Hand control for articulating needle holder. (C) Intraoperative view of needle holder with placement of 6 o'clock stitch.

vide suction and retraction. A fifth trocar is optional in cases when additional retraction is required. This trocar is placed above the left anterior iliac crest. The camera is inserted through the infra-umbilical trocar while the surgeon works through the two pararectal trocars. The endopelvic fascia is entered on both sides and a plane developed to the apex of the prostate. The dorsal vein complex is suture-ligated with 0-Vicryl on a CT-1 needle. An antegrade approach is used by first transecting the bladder and separating it from the prostate. The vasa deferentia are dissected and transected, and the seminal vesicles are sharply dissected from the tissues around them. The Denonvilliers fascia is entered and a plain is developed between the prostate and the rectum and advanced distally to the apex of the prostate. The lateral pelvic fascia is opened at the 11- and 1-o'clock positions at the anterolateral surface of the prostate on both sides. The hydrodissector is used to develop a plane between the prostate capsule and the neurovascular bundles and is advanced to the apex of the prostate (Fig 4). The hydrodissector allows an atraumatic, cautery-free dissection of the neurovascular bundles and prevents injury to the nerves.[10] The prostatic pedicles are clipped with Hem-o-loks (Hem-o-lok Ligation System,Teleflex Medical, Research Triangle Park, NC) and transected. The dorsal vein complex is transected proximal to the previously placed suture and the urethra is transected. The prostate is placed in a laparoscopic bag and removed through the infra-umbilical port site. Insufflation is re-established and an anastomosis from bladder to urethra is performed using the van Velthoven technique with a running 2-0 monofilament suture on a UR-6 needle.[11] A 20 Fr Foley catheter is left indwelling with 20 cc of water in the balloon. A drain is placed though one of the lateral trocar sites and the trocars removed. The fascia of the infra-umbilical port site is closed with a running 0-Vicryl and

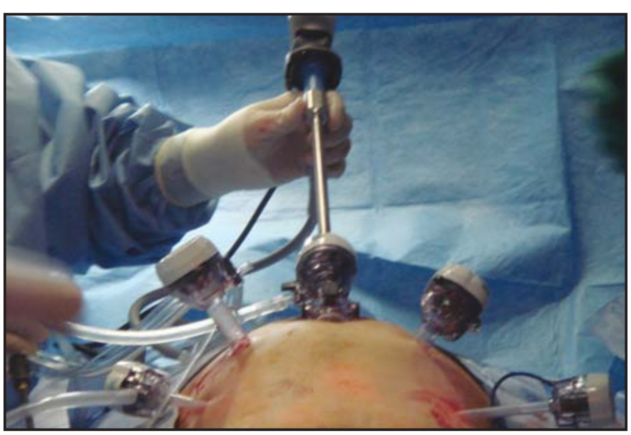

Fig 3. — Distribution of trocars.

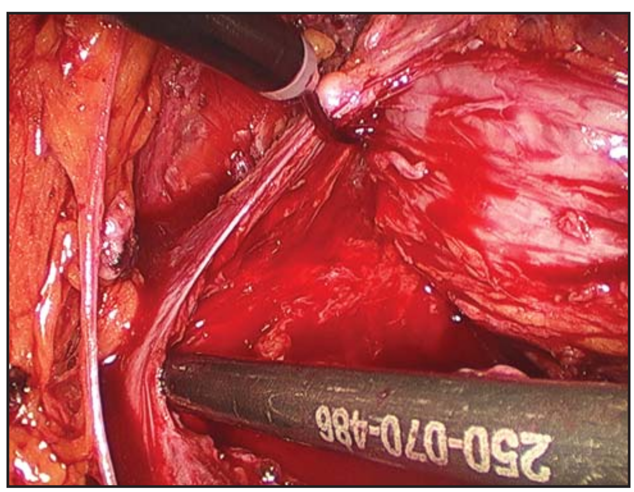

Fig 4. — Hydrodissector separating left neurovascular bundle from prostate.

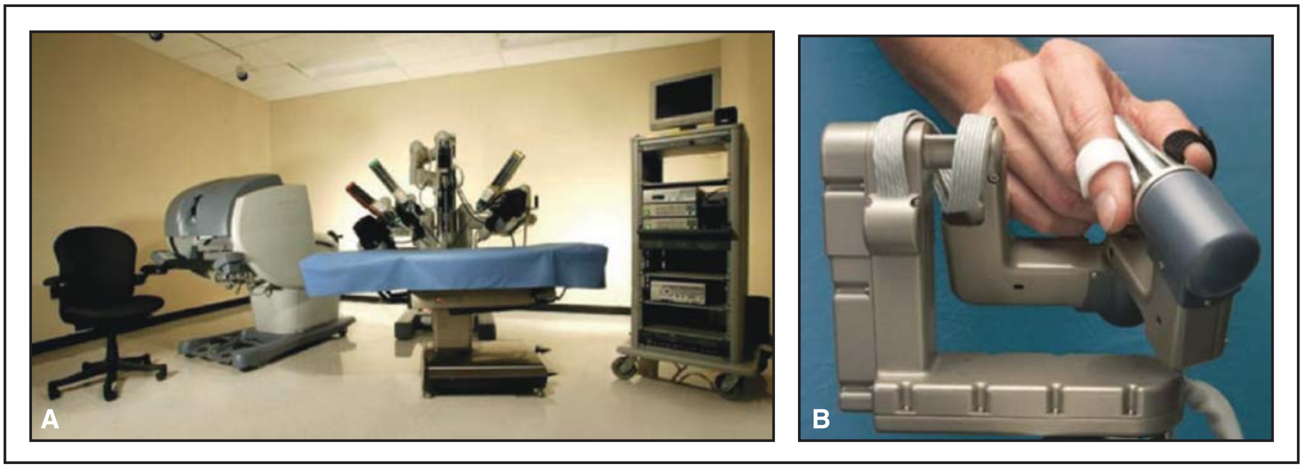

Fig 5A-B. — (A) The DaVinci robotic system. Robotic arms are above the surgical table and control console is to the right of chair. (B) The DaVinci master handle. From Costello A, Haxhimolla H, Crowe H, et al. Installation of telerobotic surgery and initial experience with telerobotic radical prostatectomy. *BJU Int.* 2005;96:34-38. Reprinted with permission by Blackwell Publishing Ltd.

all the skin sites closed with a subcuticular 4-0 Vicryl. The patient is fed the evening after surgery and discharged in the first or second postoperative day. The Foley catheter is removed 1 to 2 weeks after the surgery.

Robotic-Assisted Laparoscopic Radical Prostatectomy

Binder and Kramer[6] from the United Kingdom reported on the robotic-assisted laparoscopic radical prostatectomy in 2001. One year later, the use of this technology was popularized in the United States and Europe as a result of a report by Menon et al[7] from the Henry Ford Hospital and approval by the US Food and Drug Administration for the use of the DaVinci robot for laparoscopic prostatectomy. The Menon report described how a structured, robotic-assisted laparoscopic program was established with the assistance of two pioneers in pure laparoscopic radical prostatectomy at the Henry Ford Hospital. Working together, they concluded that incorporating robotic technology helped skilled open surgeons learn the techniques of laparoscopic radical prostatectomy.

The DaVinci robot consists of several components (Fig 5A-B). The surgical console provides the computer interface between surgeon and surgical robotic arms. The surgeon controls the robotic arms through the use of handles, which are located below the visual display. The hand movements are digitized and transmitted to the robotic arms, which perform identical movements in the operative field. Foot controls are used to move the telescope with its camera to activate electrocautery and for repositioning the handles. The binocular display in the hood of the console provides the surgeon with a 3-D view of the surgical field. The robotic arms are deactivated when the surgeon's head moves away from the display. The surgical steps are the same as with the pure laparoscopic approach with the majority of centers accessing the surgical field transperitoneally.[12]

Intraoperative Outcomes

The estimated operative time at centers of excellence ranges between 151 and 288 minutes for pure laparoscopy and between 141 and 342 minutes for robotic-assisted prostatectomy.[13-16] The transfusion rate for robotic-assisted laparoscopy is extremely low, ranging from 0% to 5%. This is one of the advantages of laparoscopic prostatectomy, since the transfusion rate for the open radical retropubic prostatectomy in centers of excellence is around 9% (Table 1).[17,18]

Intraoperative Oncologic Outcomes

Table 2 summarizes contemporary open, pure laparoscopic, and robotic-assisted series reporting on oncologic outcomes. The positive margin rate is dependent on pathologic stage. For open radical prostatectomy, the positive margin rate for pathologic T2 (organ-confined cancer) is between 19% and 29%.[17,18] For pure and robotic-assisted laparoscopic radical prostatectomy, the positive margin rates for pathologic T2 cancers is 10% to 23% and 5.7% to 19%, respectively.[19,20] The positive margin rate decreases with surgical experience.

Complications

Table 3 summarizes the complications in major series. Gonzalgo et al[31] recently applied the Claviens classification of complications[32] to laparoscopic radical prostatectomy. This classification was recently updated by Dindo et al[33] and applied to a larger series of laparoscopic prostatectomies.[34]

Functional Outcomes

Table 4 summarizes continence and potency outcomes for both pure and robotic-assisted laparoscopic radical prostatectomy. The outcomes for open, pure laparoscopic, and robotic-assisted approaches are similar, with a continence rate of 92% to 98% and potency rates of 70%.[15,17,35]

Training

As noted earlier, Menon et al[7] first addressed training in the procedure when converting from purely laparoscopic to robotic-assisted prostatectomy. They estimated that it took 18 laparoscopic prostatectomies to surpass their operative times with the pure laparoscopic approach, and later acknowledged that they were "untrainable."[36] Several investigators have reported on structured programs to train surgeons in the performance of the procedure. With a structured approach, they were able to train laparoscopic-naive surgeons.[37-39]

Comparisons Between Pure and Robotic-Assisted Laparoscopic Radical Prostatectomy

Only one series compared operative and oncologic outcomes between the two approaches, and the authors concluded that there were no differences.[40] Newer technologic developments such as the ones described in our procedure provide the laparoscopic surgeon with additional instruments to more effective-

Table 1. — Intraoperative Outcomes

Series (year)	No. of Patients	Operative Time (hrs)	Transfusion Rate (%)	Required Conversion to Open	Hospital Stay (days) (%)	Foley Catheter (days)	Operative Technique
Catalona et al[17] (1999)	1,870	–	9	–	–	–	Open
Lepor et al[18] (2001)	1,000	–	9.7	–	2.3	–	
Rassweiler et al[21] (2003)	219* 219*	288 218	30.1 9.6	3.7 0.5	12 11	7 7	Pure Laparoscopic
Guillonneau et al[22] (2003)	1,000	–	–	–	–	–	
Guillonneau et al[23] (2002)	567	203	4.9	1.2	6.2	7.8	
Chang et al[24] (2005)	400	197	0.5	0.25	3	10.6	
Goeman et al[25] (2006)	550	188	4.7	0.5	4.6	5.9	
Lein et al[14] (2006)	1,000	266	2.2	0	7	6.2	
Rozet et al[26] (2005)	600	173	1.2	0.2	6.3	7.6	
Stolzenburg et al[13] (2005)	700	151	0.9	0	–	10.7	
Rassweiler et al[27] (2006)	5,824	196.4	4.1	2.4	–	–	
H. Lee Moffitt Cancer Center & Research Institute	400	180 (last 100 cases)	5	1.5	1.5	7–14	
Mikhail et al[16] (2006)	100	341.9	5	7	1.8	6.3	Robotic-Assisted
Ahlering et al[19] (2003)	45	184 (last cases)	0	0	1.5	7	
Joseph et al[28] (2006)	325	130	1.3	0	<1	7	
Patel et al[20] (2005)	200	141	0	0	1.1	7	
Webster et al[29] (2005)	159	–	–	0.6	–	–	
Menon et al[15] (2007)	2,652	154	0	–	1.14	4–7	

* Group 1 and Group 2 underwent early and late laparoscopic radical prostatectomy, respectively.

Table 2. — Oncologic Outcomes

Series (year)	No. of Patients	Positive Surgical Margins (%)	Operative Technique
Lepor et al[18] (2001)	1,000	19.9	Open
Ramos et al[30] (1999)	1,620	T1c: 20 T2a: 23 T2b: 29	
Rassweiler et al[21] (2003)	438	21 23.2	Pure Laparoscopic
Guillonneau et al[22] (2003)	1,000	pT2a: 6.9 pT2b: 18.6 pT3a: 30 pT3b: 34	
Chang et al[24] (2005)	400	16.7	
Goeman et al[25] (2006)	550	pT2: 17.9 pT3: 44.8 pT4: 71.4	
Lein et al[14] (2006)	1,000	pT2a: 9 pT2b: 19 pT2c: 13 pT3a: 53 pT3b: 60 pT4: 100	
Rozet et al[26] (2005)	600	pT2: 14.6 pT3: 25.6	
Stolzenburg et al[13] (2005)	700	pT2: 10.8 pT3: 31.2	
Rassweiler et al[27] (2006)	5,824	pT2: 10.6 pT3a: 32.7 pT3b: 56.2	
H. Lee Moffitt Cancer Center & Research Institute	400	Pts 1-50 — pT2: 36.4 pT3: 60 Pts 51-217— pT2: 25.1 pT3: 33 Pts 218-400 — pT2: 12.8 pT3: 30	
Mikhail et al[16] (2006)	100	16	Robotic-Assisted
Ahlering et al[19] (2003)	45	pT2a: 6 pT2b: 19 pT3a: 57 pT3b: 6 pT4a: 12	
Joseph et al[28] (2006)	325	pT2a: 5 pT2b: 11.1 pT3a: 37.1 pT3b: 27.3	
Patel et al[20] (2005)	200	pT2: 5.7 pT3a: 28.5 pT3b: 27.3 pT4a: 33	
Menon et al[15] (2007)	2,652	13	

Table 3. — Complications

Series (year)	Vascular Complications (%)	Digestive Complications (%)	Urologic Complications (%)	Operative Technique
Catalona et al[17] (1999)	2.1	0.05	4.05	Open
Lepor et al[18] (2001)	0.9	0.5	1.9	
Guillonneau et al[23] (2002)	1.73	1.92	12.6	Pure Laparoscopic
Chang et al[24] (2005)	4.3	0.9	1.6	
Goeman et al[25] (2006)	2.3	0.5	6.9	
Lein et al[14] (2006)	0.8	4.2	0.7	
Rozet et al[26] (2005)	0.5	0.7	8.8	
Stolzenburg et al[13] (2005)	4.2	0.7	3.8	
Rassweiler et al[27] (2006)	3.7	3.1	3.2	
H. Lee Moffitt Cancer Center & Research Institute	2.5	2.0	12.0	
Mikhail et al[16] (2006)	4	1	4	Robotic-Assisted
Ahlering et al[19] (2003)	2.2	0	4.4	
Joseph et al[28] (2006)	3	0.3	4	

Table 4. — Functional Outcomes for Pure and Robotic-Assisted Laparoscopic Radical Prostatectomy

Series (year)	Continence 12 Months (%)	Erectile Function 12 Months (%)	Operative Technique
Catalona et al[17] (1999)	92	69	Open
Rassweiler et al[21] (2003)	90.3 91.7	–	Pure Laparoscopic
Chang et al[24] (2005)	±90	–	
Goeman et al[25] (2006)	91 (24 mos)	64 (24 mos)	
Lein et al[14] (2006)	76	–	
Rozet et al[26] (2005)	84	64	
Stolzenburg et al[13] (2005)	92	47 (6 mos)	
Rassweiler et al[27] (2006)	84.9	52.5	
H. Lee Moffitt Cancer Center & Research Institute	95.0	75 (with penile rehabilitation)	
Mikhail et al[16] (2006)	89	79	Robotic-Assisted
Ahlering et al[19] (2003)	81 (3 mos)	33 (6 mos)	
Joseph et al[28] (2006)	96 (6 mos)	68	
Patel et al[20] (2005)	98	–	
Menon et al[15] (2007)	95.2	93	

ly perform complex laparoscopic cases. Frede et al[41] reported recently on a hand-guided surgical manipulator (Radius Surgical System, Tübinger Scientific Medical GmbH, Tübinger, Germany) that provides a deflectable and rotatable tip allowing 7 degrees of freedom.

Costs

Lotan et al[42] compared costs of open, pure laparoscopic, and robotic-assisted prostatectomy. The laparoscopic radical prostatectomy was competitive with open radical prostatectomy regarding costs. The robotic-assisted laparoscopic prostatectomy was more expensive due to the high initial capital expense, the cost of disposables, and the recurrent yearly maintenance cost.

Conclusions

Laparoscopic radical prostatectomy is becoming the procedure of choice in the surgical management of early prostate cancer. Refinements in techniques and the development of new technologies will improve oncologic and functional outcomes.

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