

# Robotic Prostatectomy: A Review of Outcomes Compared with Laparoscopic and Open Approaches

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Prostate cancer affects the lives of millions of Americans each year. Since the advent of prostate-specific antigen testing, many cancers are found in initial stages and have the potential for curative resection; however, choosing which type of surgery to undergo can be a difficult task. This article reviews the outcomes of robotic prostatectomy in comparison with laparoscopic or open procedures. A PubMed search was performed to identify specific articles describing intraoperative details, surgical complications, cancer control, and continence and potency outcomes. Articles that revealed pertinent data were included in this study comparing robotic with laparoscopic or open prostatectomies. *UROLOGY* 72: 15–23, 2008. © 2008 Elsevier Inc.

The American Cancer Society projected more than 232,000 new cases of prostate cancer in 2005, accounting for 33% of male cancers.<sup>1</sup> More than 30,000 deaths will result from prostate cancer, which is the second most common cause of cancer-related death in men. It will be regionally confined in up to 90% of the cases, owing to the pervasiveness of prostate-specific antigen (PSA) screening.

Prostate cancer is treated with variations of three strategies: radical prostatectomy (RP), radiation therapy, or monitored observation (often called “watchful waiting”). Radical prostatectomy is considered by many physicians to be an effective treatment, especially for patients with organ-confined cancer and more than 10 years of life expectancy. This treatment has been shown to reduce 10-year overall mortality, disease-specific mortality, and risk of metastasis for early-stage prostate cancer.<sup>2</sup> Retropubic or perineal RP is the traditional approach to open surgery. Laparoscopic methods are also advancing, as well as robotically assisted laparoscopic prostatectomy or simply robotic RP (RRP).

Success of prostatectomy is governed by complete cancer resection, theoretically eliminating the chance for recurrence. Classically, cancer control is measured by the percentage of surgically removed tissue with positive margins. However, other measures hint at remaining tumor,

including the postoperative PSA level and biochemical recurrence.

Despite the importance of cancer control, patients are often equally concerned with any negative effects on urinary continence and sexual potency in the period immediately after surgery. Any attempt to eliminate these two functional side effects is a prime target for treatment innovations. The innovation of RRP has the potential to improve these side effects. Robotic RP introduces many benefits, including three-dimensional viewing, higher magnification, hand tremor elimination, digitized recording, and refined dexterity. These robotic features ultimately strive to maximize tumor resection, hemostasis, and nerve preservation.

This review focuses on RRP and measures of postoperative cancer control, urinary continence, and sexual potency. Comparisons of RRP with laparoscopic RP (LRP) and open RP are included for completeness.

## SEARCH METHOD

A review of the literature was conducted with PubMed, a search tool of the National Library of Medicine and the National Institutes of Health, including the MEDLINE database. The search was restricted to compare articles between open, laparoscopic, and robotic prostatectomies. Key words included “robot,” “laparoscopic,” “open,” “prostatectomy,” “continence,” “outcome,” and “potency.” This search was further refined by individual review to include only studies that referenced the outcomes of cancer control (ie, pT2, pT3, positive margins, and localized disease), urinary continence, or sexual potency. Only studies with a sample size of 40 or more patients were considered. Outcomes were tabulated from the resulting articles,<sup>3–61</sup> which were subjected to individual review.

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## RESULTS

Twenty-two robotic prostatectomy reports were identified with pertinent reported outcomes. All case reports reflected the use of a da Vinci robotic system (Intuitive Surgical, Sunnyvale, Calif). The da Vinci system is the most widely used robotic surgical device, using console-directed control of multiple robotic arms. Other surgical robots are voice-controlled, single-arm systems used for retracting assistance, or systems used to present instruments to the surgeon. Most reports attempted to show equivalency or better with laparoscopic and open approaches, and some presented large numbers of cases with long-term outcome results.

Many institutions are represented, including landmark studies from Institute Mutualiste Montsouris (Paris, France), Goethe University of Frankfurt (Germany), Vattikuti Urology Institute (Detroit, Michigan), and University of California-Irvine. More recent da Vinci installations have begun to report even more RRP, such as the University of Chicago Pritzker School of Medicine, University of Rochester Medical Center (New York), Urology Centers of Alabama (Birmingham), and Royal Melbourne Hospital (Australia), often presenting technical modifications.

### Intraoperative Data Results

The intraoperative data include operative time, estimated blood loss (EBL), complication rate including severity, and cancer control indicators. The results for operative time and blood loss are presented in Table 1. For comparison, representative data from laparoscopic prostatectomies<sup>19–30,33–35,45</sup> and open prostatectomies<sup>25,26,38,39,41,46–54</sup> are displayed below the robotic data. One large multi-institution, long-term study of open procedures, Cancer of the Prostate Strategic Urologic Research Endeavor, was also included.<sup>48</sup>

The mean operative time was 164 minutes for all 22 reports of da Vinci usage. The mean operative times from the eight sites varied between a low of 1 hour 55 minutes to a high of 13 hours. The robotic mean is comparable to the mean LRP operative time of 227 minutes and the mean open RP operative time of 147 minutes.

The mean EBL for RRP, hypothesized by many to be an advantage of the laparoscopic pneumoperitoneum and tight hemostatic control, was 152 mL (range of means, 50 mL to 570 mL). Mean EBL for LRP and open RP were greater at 406 mL and 697 mL, respectively. The intraoperative and postoperative RRP transfusion rates were generally minimal, with a mean of 2.9% of cases requiring blood. The LRP studies reported a mean of 8.3% of cases requiring blood. However, this included an LRP study in 2003 at the University of Verona (Italy)<sup>26</sup> reporting a 63% average transfusion rate (n = 71), presumably due to institutional policies rather than true need. The open RP articles reported an even higher mean transfusion rate of 24%.

Some RRP cases required conversion to laparoscopy or open RP. This was generally due to failure to proceed or difficulty establishing anatomy and rarely to complications. Of RRP, 0.5% were aborted or converted, whereas 1.5% of LRP were converted to the open approach.

A urinary catheter is required postoperatively to monitor fluid status, blood loss, and to allow time for the urethrovesical anastomosis to heal. The mean time until catheter removal after RRP varied from 6.6 to 16.7 days, with an overall mean of 8.4 days. For comparison, the mean catheter time for LRP was 6.9 days and for open RP was 8.4 days. However, catheter duration was often dictated by protocol rather than patient condition.

### Surgical Complications

Table 1 also includes the complication rates for the robotic prostatectomy studies.

Laparoscopic<sup>19–30,33–35,45</sup> and open studies<sup>25,26,38,39,41,46–54</sup> are included for comparison. The Clavien grading system (grades 1 to 5) for complications was used to evaluate morbidities.<sup>35</sup> Grade 1 morbidities are classified as deviations from the normal postoperative course. Grade 2 is defined as deviation from the normal course in addition to pharmacologic treatment or parenteral nutrition. Grade 3 is stratified into complications whose treatments do not require general anesthesia (3a) and treatments requiring general anesthesia (3b). Grade 4a indicates that single organ system damage had occurred; 4b indicates multiple organ system failure in intensive care unit settings. Clavien Grade 5 complications are death.<sup>35</sup> Not all studies indicated how each complication was treated; therefore, Clavien classifications were used with regard to severity of injury, with minor complications receiving 1 and 2 and major receiving 3 and 4, as determined by the authors. Complications ranged from minor anastomotic leaks, urinary tract infections, and trocar injuries to major pulmonary embolism, deep vein thrombosis, and anastomotic strictures. The mean overall complication rate for RRP was 6.6% (n = 5472), whereas LRP and open RP resulted in 15.6% (n = 5411) and 10.3% (n = 26,691), respectively. There was one mortality in RRP, and the mortality statistics for 26,691 open RP cases included three cases. Two deaths occurred at the Methodist Hospital in Houston, Texas; one death was due to sepsis 38 days postoperatively after a strangulated hernia, and one death was due to cardiac arrest 30 hours postoperatively after disseminated intravascular coagulation.<sup>47</sup> One additional death occurred within 30 days postoperatively after myocardial infarction at home.<sup>49</sup>

### Oncologic Outcomes

Cancer control (Table 1) is indicated by the presence or absence of positive surgical margins (PSM) according to pathologic tumor grades pT2 and pT3. Additional data from laparoscopic<sup>19–30,33–35,45</sup> and open<sup>25,26,38,39,41,46–54</sup> prostatectomies are presented for comparison. Because radical prostatectomy is generally reserved for patients

**Table 1.** Intraoperative outcomes, cancer control, and surgical complications

Study (Reference)	Year	N	OR Time	Mean EBL	Complications (Clavien) (%)			Overall Tumor Rate (%)		Positive Margin Rate (%)		
					Overall	3 and 4	1 and 2	pT2	pT3	pT2	pT3	Overall
<b>Robotic</b>												
Ahlering (3)	2003	45	209 (150–600)	145 (25–350)	13.3	6.7	6.7	60	35	14.8	62.5	35.5
Bentas (4)	2003	40	500 (246–780)	570 (100–2500)	32.5	12.5	20	62.5	37.5	8	67	30
Tewari (5)*	2003	200	160 (71–315)	153 (25–750)	3.5	2	1.5	87	13	—	—	6
Wolfram (7)	2003	81	250 (150–390)	300 (100–1500)	—	—	—	68.5	31.5	12.7	42	22
Ahlering (8, 9)	2004	200	—	108 (25–400)	6.7	3.3	3.3	72	26	6.5	32	20.4
Cathelineau (10)	2004	105	180 (120–290)	500 (150–2000)	—	—	—	71	29	22	43	22
Ahlering (11, 12)	2005	109	—	92 (25–250)	8	0	8	—	—	—	—	13
Ahlering (13)	2005	100	247 (160–645)	120 (25–400)	9	—	—	75	25	10	15	25*
Chien (14)	2005	56	356 (240–480)	356 (25–1200)	9	—	—	82	18	—	—	10.7
Costello (15)	2005	122	—	—	19	—	—	80	20	—	—	16.3 <sup>†</sup>
Joseph (16)	2005	50	202 ± 38	206 ± 63	8	—	—	88	12	—	—	12
Menon (17)	2005	76	115	102.3	—	—	—	95	—	—	—	3
Patel (18)	2005	200	141.2	75.1	1	—	—	78	19	5.7	26	10.5
Hu (19)	2006	322	186 (114–528)	250 (50–1600)	14.6	—	—	—	—	—	—	—
Menon (32)	2006	1142	154 (71–387)	142 (10–750)	2.3	0	2.3	77.7	22	—	—	13
Patel (31)	2006	500	130 (51–330)	50 (10–300)	—	—	—	78	20	2.5	13.8	9.4
Tewari (42)	2007	215	150 (120–240)	150	—	—	—	—	—	4.7	—	6.5
Tewari (43)	2007	700	—	—	—	—	—	83.5	14.1	—	—	5.2
Badani (44)	2007	2766	154 (71–387)	142 (10–1350)	14.9	0.6	11.7	77.7	22	13	35	12.3
Weighted means		5472	164	152	6.6	1.3	7.1	77.4	21.5	10.3	30.4	12.5
Note: Clavien 5 complication = 1												
<b>Laparoscopic</b>												
Hoznek (20)	2001	134	271 (150–500)	1230 (200–3500)	8.9	4.5	4.5	75	24	16.8	48.8	24.5
Rassweiler (21)	2001	180	255	185	14.4	—	—	49	45	2.3	23	16
Turk (22)	2001	125	245 (145–600)	313	—	—	—	62	38	—	—	26.4
Eden (23)	2002	100	203 (90–500)	380	18.5	3.7	14.6	—	—	—	—	—
Guillonneau (24)	2002	567	—	—	—	—	—	71.7	28.2	—	—	26.5
Anastasiadis (25)	2003	230	180 (120–240)	—	37	—	—	60	33	14	43.5	30
Artibani (26)	2003	71	—	—	—	—	—	77.5	22	15.5	31	19.2
Guillonneau (27)	2003	1000	—	—	—	—	—	—	—	—	—	—
Gonzalzo (35)	2004	246	—	—	13.8	4.5	9.3	—	—	—	—	—
Martina (28)	2005	114	160 (90–360)	—	14	—	—	74	26	7.4	48.3	17
Rassweiler (29)	2005	500	—	—	—	—	—	59.2	35.2	7.4	31.8	19
Rozet (30)	2005	600	173 (95–300)	380 (20–3500)	11.2	2.3	9.2	72.0	28.0	14.6	25.6	17.7
Soderdahl (45)	2005	110	—	—	—	—	—	87.3	10.9	13.5	50	18.2
Hu (19)	2006	358	246 (150–768)	200 (0–1500)	27.7	—	—	—	—	—	—	—
Lein (34)	2006	1000	266 (102–810)	—	11.8	10.2	1.6	70.2	29.4	15.0	21.1	—
Gill (33)	2006	76	250	304	—	—	—	—	23	—	—	8
Weighted means		5411	227.5	405.8	15.6	6.2	7.7	70.4	27.3	20.2	28.1	19.6

\* This study was conducted with Dr. Menon at Henry Ford.

Continued

**Table 1.** *Continued*

Study (Reference)	Year	N	OR Time	Mean EBL	Complications (Clavien) (%)			Overall Tumor Rate (%)		Positive Margin Rate (%)		
					Overall	3 and 4	1 and 2	pT2	pT3	pT2	pT3	Overall
Open			—	600	—	2.9	—	—	—	—	—	—
Zinke (46)	1994	1728	182 (95–325)	(800–1200)	27.8	9.8	21.4	—	—	—	—	—
Dillioglugil (47)	1997	472	—	—	—	—	—	70.0	22.7	36.7	68.3	34
Grossfeld (48)	2000	1383	—	818	6.6	2.2	4.4	76.2	21.5	—	—	19.9
Lepor (49)	2001	1000	—	—	—	—	—	100	0	—	—	10
Walsh (39)	2001	50	—	—	—	—	—	—	—	—	—	—
Hull (50)	2002	1000	—	—	—	—	—	59.8	25.2	—	—	12.8
Anastasiadis (25)	2003	70	179 (139–219)	—	13.1	—	—	65.7	34.2	—	—	28.6
Artibani (26)	2003	50	105 (50–157)	—	20	—	—	66	26	6	46.2	24
Hsu (41)	2003	1024	131 (50–380)	813 (100–3000)	6.2	—	—	—	—	—	—	20.6
Han (51)	2004	9035	—	—	—	—	—	58	38	7.7	26.9	14.7
Kundu (52)	2004	3477	—	—	9	4.1	5	68.0	31.3	—	—	—
Roehl (53)	2004	3478	—	—	—	—	—	68.0	31.0	—	18.1	19
Ward (54)	2004	7268	—	—	—	—	—	69	31.0	28	58	38
Saranchuk (38)	2005	1133	—	—	—	—	—	76.8	21.5	—	—	13
Weighted means		26691	147.1	697	10.3	4.0	6.4	65.2	32.0	18.3	38.9	23.5

Note: Clavien 5 complication = 4

OR time = operating room time (in minutes); EBL = estimated blood loss (in milliliters); pT = pathologic stage.

OR Time and EBL data are presented as mean (range) or mean ± standard deviation. Weighted means have been calculated only weighting each patient once, although the same patients are presented in multiple series.

\* pT3 and pT4.

† Clinical stage.

**Table 2.** Urinary continence outcomes

Study (References)	Year	N	Evaluated Patients (n)	Age (y)	Follow-Up (mo)				
					1	3	6	12	≥18
<b>Robotic</b>									
Ahlering (3)	2003	45	—	61.4 (46–71)	63	81	—	—	—
Bentas (4)	2003	40	38	61.3 (45–72)	—	84	—	—	—
Tewari (5)**	2003	200	—	59.9 (42–76)	—	—	96	—	—
Ahlering (8, 9, 13)	2004	300	202	62.9 (43–78)	—	77	—	—	—
Costello (15)	2005	122	89	—	—	73	82	—	—
Joseph (16)	2005	50	50	59.6 ± 1.6	72	90	—	—	—
Patel (18)	2005	200	200	59.5 (40–78)	47	82	89	98	100
Menon (32)	2006	2652	1142	60.2 (39–80)	50	90	—	95	—
Patel (31)	2006	500	500	63.2	—	89	95	—	—
Tewari (43)	2007	182	182	62.1	—	91	97	—	—
<b>Laparoscopic</b>									
Rassweiler (21)	2001	180	179	64 (46–77)	36	54	74	97	—
Turk (22)	2001	125	—	59.9 (37–72)	—	75	86	92	—
Eden (23)	2002	100	—	62.2 (52–72)	11	63	85	90	—
Guillonneau (57)	2002	550	255	—	—	—	73	82.3	—
Anastasiadis (25)	2003	230	106	64.1 (46–77)	—	—	—	89*	—
Artibani (26)	2003	71	20	64.3	—	—	—	60	—
Rassweiler (58)	2004	500	500	64.0	—	—	—	83.6	—
Link (55)	2005	122	122	58.3 ± 6.2	—	51	89.9	93.4	—
Martina (28)	2005	114	114	66 (45–78)	71	94	96	—	—
Rozet (30)	2005	600	498	62 (47–73)	—	—	—	98	—
Lein (34)	2006	1000	952	62 (56–68)	—	—	—	—	76
<b>Open</b>									
Stanford (56)	2000	1291	1291	62.9 (39–79)	—	—	38.6 <sup>†</sup>	60.5 <sup>†</sup>	58
Walsh (59)	2000	64	64	57 (36–67)	—	54	80	93	93
Anastasiadis (25)	2003	70	33	64.8 (50–75)	—	—	—	77.7*	—
Artibani (26)	2003	50	14	64.3	—	—	—	78.5	—
Kundu (52)	2004	3477	2737	61 ± 7.4	—	—	—	93	—
Lepor (60)	2004	500	491	58.8 ± 0.3	—	70.9	87.2	92.1	98.5

Age reported as mean (range) or mean ± standard deviation.

\* Excludes nocturnal continence.

<sup>†</sup> No category was supplied for use of a single security-only pad.

\*\* This study was conducted with Dr. Menon at Henry Ford.

with localized tumors (pT1 to pT2) or minimal capsular/seminal vesicle invasion (pT3), most results represented patients with these tumor grades. Robotic RPs were categorized as 77.4% pT2 tumors and 21.5% pT3 tumors. Laparoscopic RPs were performed on 70.4% pT2 versus 27.3% pT3 tumors, and open RPs for 65.2% pT2 and 32.0% pT3 tumors.

A high total PSM rate is an indication of poor cancer control with an increased risk of recurrence. Robotic RPs revealed the lowest mean PSM rate of 12.5%, whereas LRP and open RP yielded a PSM of 19.6% and 23.5%, respectively. Although the pathologic stage indicates that more pT2 lesions were performed in robotic series, the clinical staging for many series was comparable. In the laparoscopic series by Link *et al.*<sup>55</sup> and Gonzalzo *et al.*,<sup>35</sup> 100% of their cohorts had either cT1 or cT2 disease preoperatively. In the Stanford open series,<sup>56</sup> 100% of the patients were either cT1 or cT2. The Saranchuk *et al.* open series<sup>38</sup> classifies 91.5% as either cT1 or cT2. The Walsh *et al.* Cavermap study<sup>39</sup> had 100% of patients with either cT1 or cT2 disease. Hsu *et al.*<sup>41</sup> reported a series in which 99.8% of patients had either cT1 or cT2 disease. Although pathologic data seem to show that more pT2 lesions are performed in robotic

prostatectomy, this is not necessarily true because preoperative data show that many series classify the vast majority of their patients as either cT1 or cT2.

### Urinary Continence Outcomes

Postoperative urinary continence is another major outcome we evaluated. These results are tabulated in Table 2 along with comparative laparoscopic studies<sup>21–23,25,26,28,30,34,55,57,58</sup> and open surgery studies.<sup>25,26,52,56,59,60</sup> The large, long-term, multi-institute Prostate Cancer Outcomes Study (PCOS) of 2000 was included with the open prostatectomy category.<sup>56</sup>

Continence is defined using many different criteria, depending on the investigator. For this review, continence was defined as requiring no absorbent pads or 1 security pad. However, to further complicate the issue, some investigators used the category “0 to 1 pad” without indicating whether the single pad was for security or for true incontinence.

Age is a critical factor for predicting postoperative continence. The mean age for the RRP studies ranged from 59.5 to 63.2 years. This was contrasted with the mean age for LRPs and open RPs of 58.3 to 66 years and 57 to 64.8 years, respectively.

**Table 3.** Sexual potency outcomes

Study (Reference)	N	Evaluated Patients (n)	Age (y)	UNS (%)	BNS (%)	NNS (%)	Follow-up (mo)	BNS % Intercourse	UNS % Intercourse	Intercourse %
<b>Robotic</b>										
Ahlering (3)	45	3	61.4	27	60	13	≤12	33	0	33
Bentas (4)	40	37	61.3	—	—	—	12	—	—	21.1
Tewari (5)*	200	120	59.9	—	60	—	≤12	50	—	50
Ahlering (11)	110	59	56.1	12.7	40.9	0	<12	24.4	14.3	—
Chien (14)	80	56	58.9	25	35	10	12	35.7	40	40
Joseph (16)	50	50	59.6	2	92	6	<12	—	—	46
Menon (17)	58	58	60.5	—	97	—	12	46.6	74	—
Patel (31)	500	200	63.2	—	—	—	12	—	—	78
Zorn (37)	300	258	59.4	26.3	59.7	11	12	80	61	—
Menon (32)	2652	1142	60.2	25	42	—	12	97	74	—
Tewari (43)	215	215	60.0	11	85	4	12	87	—	87
<b>Laparoscopic</b>										
Badani (44)	910	721	60.0	—	—	—	12	79.2	—	79.2
Hoznek (20)	134	25	64.8	—	—	—	12	—	—	56
Turk (22)	125	44	59.9	11	89	—	<15	—	—	59
Eden (23)	100	64	62.2	6	58	—	12	62	—	62
Guillonneau (57)	550	47	—	0	100	—	12	66	—	66
Rassweiler (58)	500	109	64	62.4	37.6	—	12	67	—	67
Link (55)	122	122	58.3	32.8	48.4	18.9	12	78.9	64	54.3
Martina (28)	114	114	66	21.1	0	—	<12	—	47.2	32
Rozet (30)	600	89	62	21.3	63.7	15	<12	43	—	43
Wagner (36)	220	60	—	27	66	6	12	72	35	—
Gill (33)	200	76	—	—	38	—	12	88	—	53.9
Rassweiler (61)	562	562	—	38.8	61.2	—	—	76	67	—
<b>Open</b>										
Walsh (59)	64	64	57	—	89	—	18	86	—	86
Kundu (52)	3477	1834	61	4	91	5	>18	76	53	75
Saranchuk (38)	1133	647	58	6.6	92.5	0.9	24	62	—	62
Walsh (39)	50	50	52.5	10	90	—	12	76	—	78
Hsu (41)	1024	293	60.9	—	—	—	24	—	—	46.4
Michl (40)	411	389	63.5	29.3	70.6	—	12	36.7	16.7	—
Stanford (56)	1291	1042	62.9	—	—	—	18	44.0	41.4	14.7

UNS = unilateral nerve-sparing surgery; BNS = bilateral nerve-sparing surgery; NNS = non-nerve-sparing surgery.

97% is via the veil technique; 74% is via the non-veil technique.

BNS % intercourse refers to antegrade technique; UNS % refers to retrograde technique.

\* This study was conducted with Dr. Menon at Henry Ford.

Some investigators reported only short-term data, often limited to less than 3 months of follow-up. Six RRP studies reported data beyond 6 months.<sup>5,15,18,31,32,43</sup> The RRP outcomes ranged from 73% to 91% continence at 3 months' follow-up and from 82% to 97% at 6 months' follow-up. The Patel 2005 study<sup>18</sup> reported longer-term data, with 98% continence at 12 months' follow-up and 100% continence beyond 18 months (n = 200).

In contrast, LRP results ranged from 51% to 94%, 73% to 96%, and 60% to 98% at 3, 6, and 12 months' follow-up, respectively. Reports for open RPs revealed continence rates of 54% to 70.9%, 38.6% to 87.2%, and 60.5% to 92.1% at 3, 6, and 12 months' follow-up, respectively. Long-term results were also reported for open RPs, with a range of 58% to 98.5% continence beyond 18 months' follow-up.

### Sexual Potency Outcomes

Another major outcome, sexual potency, is detailed in Table 3, along with comparative laparoscopic<sup>20,22,23,28,30,33,55,57,58</sup> and open surgery<sup>38-41,52,56,59</sup> data. Age is an important factor for postoperative potency, and baseline potency is

usually assumed. The ranges of mean ages for RRP, LRP, and open RPs were 56.1 to 63.2 years, 58.3 to 66 years, and 57 to 63.5 years, respectively. The type of nerve-sparing procedure performed was also indicated for the basis of comparison from pertinent data. The theory used here is that patients with bilateral nerve-sparing procedures should have better functional outcomes than those with only unilateral or nerve-excising procedures.

Potency, much like continence, has no clear definition but is often suggested by the ability to have a spontaneous erection and/or maintain an erection sufficient for intercourse. Different investigators used different ways to assess potency; most studies included some form of questionnaire (International Index of Erectile Function, Expanded Prostate Cancer Index Composite [EPIC]) and also included telephone or personal interviews. Investigators used classifications such as "most times," "almost always," and "no difficulty" in the EPIC questionnaires regarding "ability to maintain/achieve intercourse/penetration." The data are presented in concordance with which type of nerve-sparing procedure was performed and their respective potency outcomes.

Evaluating RRP, patients who had received the unilateral and bilateral nerve-sparing surgery had a range of 14.3% to 61% and 24.4% to 97% potency, respectively, at 12 months. Regarding LRP, patients who received unilateral and bilateral nerve-sparing procedures had ranges of 35% to 64% and 43% to 78.9%, respectively, at 12 months. Open RP patients who received unilateral and bilateral nerve-sparing procedures had ranges of 16.7% to 53% and 36.7% to 86%, respectively, between 12 and 24 months postoperatively.

Again, the open prostatectomy results from the 2000 PCOS were included.<sup>56</sup> The results of the 2000 PCOS reported potency for bilateral nerve-sparing versus unilateral nerve-sparing procedures of 44% versus 41.4%, with the intent to show potency improvement for bilateral nerve-sparing procedures.<sup>56</sup> Some other studies of only bilateral nerve-sparing procedures<sup>17,23,30,56–59</sup> demonstrated potency rates on the higher end of the ranges, but significance was not obvious.

## CONCLUSIONS

The patient with localized prostate cancer is presented with multiple surgical options for a potential cure. Selecting between open RP, LRP, and RRP is a daunting task for both the patient and the practitioner.

Patients ultimately want to know which surgery will remove the maximum tumor with the minimum of complications, all while preserving normal urinary and sexual function. Ideally, to fulfill this objective, we would consult multiple randomized controlled trials representative of the patient's demographics and condition, comparing each surgical option. Unfortunately only one randomized trial has reported on this issue, comparing open RP with watchful waiting.<sup>60</sup>

Laparoscopic radical prostatectomy, with or without robotic assistance, is considered a newcomer among prostate cancer treatments. Only observation case series are available for outcome information, and most of these are initial cases and single-institution studies. Data are biased by the use of a few surgeons and limited patient demographics based on institution location and selection criteria. However, the frequency of LRPs and RRP is expanding every year, and broader data will hopefully be available soon.

Turning to the available case series, additional problems are apparent in the interpretation of the data. No single reporting standard has been adopted, so comparing studies is complicated. It is often necessary to tabulate only the most basic outcome information, as was the case for this review. For example, many evaluation instruments have been developed and validated for recording urinary symptoms. Because few investigators have used these systems to date, they were not useful for comparing multiple cases series.

Also, case series are severely influenced by selection criteria. Often a particular institution or surgeon will limit their patients to younger age groups, lower-grade

tumors (eg, pT2), or those without comorbidities and thereby favorably skew the outcomes. The results of this review must be understood within the context of single-institution case studies.

Certain data can suggest a theoretically superior postoperative outcome, such as a shorter operative time, less operative blood loss, fewer blood transfusions, infrequent conversion to an open procedure, and shorter postoperative urinary catheter use. Other data can more directly influence the choice of surgical procedures, such as cancer control, complication rate, and mortality rate. In addition, for some patients, information about the degree of postoperative urinary continence and sexual potency are essential for this decision.

Regarding the intraoperative variables, a few useful points can be cautiously developed. Robotic RP and LRP have traditionally been regarded as time consuming. One would expect to find shorter operative times for open RPs. However, with growing years of surgeon experience and refinements, RRP, LRP, and open RP operative times have become very similar, with means of 164, 227, and 147 minutes, respectively.

Conversely, blood loss with open procedures is generally considered to be greater than with laparoscopy, owing to the benefits of pneumoperitoneum and precision hemostasis. This point was demonstrated when comparing the mean EBL: for RRP being 152 mL, for LRP 406 mL, and for open RP 697 mL. Blood transfusions during or after radical prostatectomy have become atypical, although a few centers routinely transfuse autologous blood even without clinical indications. Even considering the small sample sizes, only 34 of 1168 patients were transfused for RRP, yet 157 and 780 patients were given blood for LRP or open RP, respectively.

Catheter time has become rather standardized at most institutions and is governed by the surgical approach. The removal of the catheter is not always directly linked with a secure and healed anastomosis or an ideal recovery. Nevertheless, the mean catheter time for RRP, 8.3 days, does not seem to be improved from those of LRPs (6.9 days) or open RPs (8.4 days). The conversion from RRP or LRP to an open procedure is so rare that little information can be gleaned from the review results.

Cancer control is crucial for any procedure with intent to cure. For this review, PSM was used to imply that the entire tumor was not excised and recurrence theoretically probable. The mean PSM for RRP was 12.5%, compared with 19.6% and 23.5% for LRPs and open RPs, respectively. The tremor-free ability to visualize the three-dimensional, magnified operative field and perform exacting movements, intuitive suturing action, expanded degrees of freedom, and relaxed surgeon position may have contributed to this decreased percentage of positive surgical margins. The open and laparoscopic series included greater numbers of pT3 lesions, which could have had an impact on negative margins. Negative surgical margins are much more difficult and infrequent for pT3

versus pT2 tumors. This hypothesis was supported by this review: the PSM rate for pT3 tumors was greater than for pT2 tumors, irrespective of the surgical procedure.

Mortality was present in four open and one robotic procedure. The overall complication rate for RRP was 6.6%, compared with nearly 15.6% and 10.3% for LRP and open RP, respectively. Complications were assessed using the Clavien classification system, although owing to incomplete treatment outcomes each was divided into major and minor complications by discretion of the study authors.

The urinary continence and sexual potency results are much more difficult to understand because of the non-standard reporting methods. Older patients are much more likely to have delayed or continued incontinence generally.<sup>62</sup> Thus the selection bias for single-institution studies limits our ability to attribute meaning to the results. Despite this restriction, some significance may be derived from the range of continence means. The range seems to be narrower (73% to 91%) for RRP as opposed to LRP (51% to 94%) and open RP (54% to 70.9%) at 3 months' follow-up. This effect seems to continue at 6 months' follow-up, suggesting refined control and increased reproducibility with RRP. Any definitive inference regarding the best procedure for continence awaits randomized controlled study results.

Sexual potency is also contingent upon age and subject to misinterpretation from case series. Because some institutions advance nerve-sparing procedures, studies are again biased. It is difficult to ascertain conclusions reliably from the available data. The percentage of patients able to achieve a postoperative erection is nearly the same, regardless of the procedure, with 24% to 97% for RRP, 7.9% to 85% for LRP, and 14% to 86% for open RP. The ability to maintain an erection sufficient for intercourse is a classic symbol of potency. Sparse data are available when comparing bilateral with partial or unilateral nerve-sparing procedures for any of the approaches. As newer nerve-sparing and prostatic fascial-sparing procedures are being realized with laparoscopy and newer robotic instruments are being implemented, results will likely change, and future studies will be needed to illuminate this issue.

Newer prostate cancer treatment options continue to appear. Plans range from newer radiation therapies, photocoagulation, and ultrasound to cryosurgery and gene therapy. As these new therapies are implemented, research resources will be stretched to properly study RRP outcomes. The gold standard of evaluation tools, the randomized controlled trial, is required in the future to help direct prostate cancer patients and practitioners. Nevertheless, robotic surgery seems to be sought after by many patients and continues to be refined.

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