A Direct Comparison of Robotic Assisted Versus Pure Laparoscopic Radical Prostatectomy: A Single Institution Experience

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Purpose: We compared a single institution experience with radical prostatectomy using a pure laparoscopic technique vs a robotically assisted technique with regard to preoperative, intraoperative or postoperative parameters.

Materials and Methods: From May 2003 to May 2005 we reviewed 133 consecutive patients who underwent extraperitoneal robot assisted radical prostatectomy and compared them to 133 match-paired patients treated with a pure extraperitoneal laparoscopic approach. The patients were matched for age, body mass index, previous abdominopelvic surgery, American Society of Anesthesiologists score, prostate specific antigen, pathological stage and Gleason score. Preoperative, perioperative and postoperative data, including complications and oncological results, were analyzed between the 2 groups.

Results: The 2 groups were statistically similar with respect to age, body mass index, prostate specific antigen, Gleason score and clinical stage. No statistical differences were observed regarding operative time, estimated blood loss, hospital stay or bladder catheterization between the 2 groups. The transfusion rate was 3% and 9.8% for laparoscopic radical prostatectomy and robotic assisted laparoscopic prostatectomy, respectively ($p = 0.03$). Conversion from robotic assisted laparoscopic prostatectomy to laparoscopic radical prostatectomy was necessary in 4 cases. None of the laparoscopic radical prostatectomy cases required conversion to an open technique. The percentage of major complications was 6.0% vs 6.8%, respectively ($p = 0.80$). The overall positive margin rate was 15.8% vs 19.5% for laparoscopic radical prostatectomy and robotic assisted laparoscopic prostatectomy, respectively ($p = 0.43$).

Conclusions: We demonstrated that the laparoscopic extraperitoneal radical prostatectomy is equivalent to the robotic assisted laparoscopic prostatectomy in the hands of skilled laparoscopic urological surgeons at our institution with respect to operative time, operative blood loss, hospital stay, length of bladder catheterization and positive margin rate.

Key Words: prostatic neoplasms, prostatectomy, laparoscopy, robotics

Radical prostatectomy is recognized as standard treatment for localized prostate cancer in young patients. Historically, Schuessler et al attempted the first LRP in 1992.[1] They published their series of 9 prostatectomies concluding that the procedure offered no advantage compared to the standard open radical prostatectomy.[1] In that same year Raboy et al performed the first extraperitoneal LRP.[2] In 1998 Vallancien and Guillonneau began performing their first LRPs at Montsouris.[3] After refining the technique of LRP, patients began to experience the documented benefits of decreased postoperative convalescence.[4,5]

Although digitally enhanced laparoscopic images are considerably improved by features such as magnification and illumination, laparoscopic surgery requires acquisition of new anatomical perspectives, hand-eye coordination, the capacity to operate limited tactile feedback and lack of 3-dimensional vision. In addition, surgeons working with the conventional laparoscope have limited dexterity compared with open surgery. All these restrictions contribute to the steep learning curve of laparoscopy. These shortcomings have to lead to the concept that robots may improve the precision and accuracy of anatomical dissection. In May 2000 Binder performed the first RALP. Shortly thereafter, Vallancien performed an RALP with Menon who would go on to develop the technique.[6]

Few studies in the literature exist that perform a direct comparison between LRP and RALP from a single institution. Those studies that do exist are of a limited number of patients. We performed a retrospective direct comparison of patients who underwent a RALP to match-paired patients who underwent a LRP at our institution to determine if there was an advantage of 1 technique compared to the other at a high volume laparoscopic referral center.

METHODS

Patient Selection

A total of 133 patients underwent an extraperitoneal RALP performed at our institution between May 2003 and May 2005 using the da Vinci® Surgical System. During this same time a total of 758 extraperitoneal LRPs were performed at our institution. The preoperative, operative and postoperative data were recorded prospectively in our database. A match-paired analysis of the LRP patients was performed with respect to age, body mass index, previous abdominal surgery, patient ASA score, preoperative PSA, clinical stage and Gleason score to compare the 2 groups equally.

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Surgical Technique

Between May 2003 and May 2005 the radical prostatectomies (laparoscopic or robot assisted) were performed at the Institut Montsouris by 1 of 4 surgeons (GV, XC, FR and EB) via an extraperitoneal approach. The extraperitoneal approach is the preferred technique at our institution for both the LRP and RALP. This approach avoids the peritoneal cavity and the associated risk of intraperitoneal injury. Also, postoperative complications such as urinary leaks and bleeding are contained within the extraperitoneal space which limits the severity of these complications. Nerve sparing procedures were performed for preoperatively potent patients, with a clinical stage of T1 or T2, and a PSA of 10 ng/ml or less. Intraoperative frozen section analysis was obtained during the nerve sparing procedures. The operative technique has been previously described in detail.[7] The same basic operative technique is used for the RALP. The only modification to either procedure during the study period was with the robotic procedure. The last 50 cases were performed using a Maryland bipolar forceps instead of the standard bipolar forceps.

Data Analysis

Patients were classified into 1 of 3 groups using the D'Amico risk stratification based on preoperative PSA, biopsy Gleason score and clinical T stage.[8] Several operative and perioperative parameters were evaluated between the 2 procedures, including operative time, estimated blood loss, transfusion rate, length of hospital stay and bladder catheterization. Morbidities and complications along with margin status were also evaluated. To categorize the morbidities, the recently updated conventional complication classification system by Dindo et al was used.[9] A positive surgical margin was defined as presence of tumor at the inked surface of the specimen. The oncological results were evaluated by staging the operative specimens according to the TNM 2002 classification.

Statistical Analysis

StatView® was used for the statistical analysis. The numeric parameters between both groups were compared using Student's t test or the Mann-Whitney U test where appropriate. The chi-square test was used for comparison of nominal data. A p value of 0.05 was considered statistically significant. The results were expressed as mean and range.

RESULTS

Preoperative Data

A total of 133 patients underwent RALP and were match-paired to 133 patients who underwent a LRP between May 2003 and May 2005. The mean age of patients undergoing RALP and LRP was 62.0 and 62.5 years, respectively ($p = 0.46$). The patient demographic characteristics for both the LRP and the RALP groups are compared in table 1. According to match-pairing, both groups were statistically similar with respect to age, BMI, ASA score and previous abdominal/pelvic surgical history. The preoperative oncological characteristics for both groups can be seen in table 2. The preoperative PSA level, biopsy Gleason score and clinical stage, and D'Amico risk stratification were also statistically similar between the 2 study groups.

TABLE 1. *Preoperative patient demographics*

	RALP	LRP	p Value
Mean age (range)	62.0 (49–76)	62.5 (47–74)	0.46
BMI:			
Mean (range)	24.8 (18.8–35.5)	25.3 (19.3–32.7)	0.31
No. less than 25	74	74	1.0
No. 25–30	53	53	1.0
No. 30 or greater	6	6	1.0
No. previous abdominal/ pelvic surgery:			
Yes	51	51	1.0
No	82	82	1.0
No. ASA score:			
1	57	57	1.0
2	74	74	1.0
3	2	2	1.0

Intraoperative and Perioperative Data

Four (3.0%) patients in the RALP group required conversion to a pure laparoscopic radical prostatectomy because of dissection difficulties with the da Vinci system. All of these cases were completed via the laparoscopic approach successfully. None of the patients in the LRP group were converted to an open procedure.

The intraoperative and perioperative data can be seen in table 3. No statistical difference regarding the number of lymph node dissections or nerve sparing procedures performed was observed between the 2 groups. A bilateral and unilateral nerve sparing procedure was performed in 96 (76.2%) and 30 (23.8%) cases, respectively, for LRP vs 91 (72.2%) and 35 (27.8%), respectively, for RALP. The mean operative time for the entire procedure was 160 minutes (range 90 to 270) for LRP vs 166 minutes (range 90 to 300) for RALP ($p = 0.09$). The mean operative blood loss was 512 ml (range 70 to 1,800) for LRP vs 609 ml (range 100 to 3,000) for RALP ($p = 0.07$). The blood transfusion rate in LRP and the RALP was 3% vs 9.8%, respectively. The observed difference in transfusion rate reached statistical significance ($p = 0.02$).

Since there was a modification to the robotic procedure during the study period when the bipolar instrument used during the procedure was changed we compared the operative blood loss of the first 83 patients (standard robotic bipolar forceps) compared to the last 50 patients (Maryland bipolar forceps) in the RALP group. The operative blood loss for the first 83 patients and the last 50 patients was not statistically significant.

Postoperative Data

Mean hospital stay was 4.9 days and 5.4 days and bladder catheterization was 9.0 and 9.2 days for the LRP and RALP, respectively. A statistically significant difference was observed regarding the overall complications rate between the 2 groups (table 4). Complications occurred in 12 cases (9.1%) in the LRP group vs 26 (19.4%) in the RALP group ($p = 0.01$). There were more minor complications (grade I and II) in the robot assisted group. There was not a statistically significant difference in the major complication rate between the 2 groups ($p = 0.80$). No deaths or cardiac complications were observed in either group.

Pathological Data

Overall, there was no statistical difference between the 2 groups regarding the pathological evaluation. The results

TABLE 2. *Preoperative oncological characteristics*

	RALP	LRP	p Value
No. D'Amico criteria:			
Low risk	80	80	1.00
Intermediate risk	49	49	1.00
High risk	4	4	1.00
Mean PSA (range)	7.6 (0.9–38.0)	7.8 (3.2–19.0)	0.81
No. clinical stage (%):			
T1b	0	1 (0.8)	
T1c	76 (57.1)	90 (67.7)	
T2a	51 (38.3)	39 (29.3)	
T2b	6 (4.5)	2 (1.5)	
T3a	0	1 (0.8)	
Gleason score:			
Mean (range)	6.3 (4.0–9.0)	6.3 (4.0–9.0)	0.32
No. 6 or less (%)	101 (76)	93 (70)	
No. 7 (%)	29 (21.8)	37 (27.8)	
No. greater than 7 (%)	3 (2.2)	3 (2.2)	
% Mean pos biopsy	27.1	29.9	0.21

are summarized in table 5. The rate of positive surgical margins was 15.8% and 19.5% in LRP and RRP, respectively ($p = 0.42$). The dominant site of positive margins was at the apex for both groups. The margins were diagnosed in 15.5% and 16.6% of the pT2 and pT3 tumors in the LRP group, and 13.0% and 20.9% of the pT2 and pT3 in the RALP. To date, there has been no incidence of port site metastasis.

DISCUSSION

Radical prostatectomy continues to be the gold standard for organ confined disease in young men. The goal of its laparoscopic counterpart is to match the cancer control outcomes of open prostatectomy but improve upon the open procedure with the benefits of the laparoscopic approach, including faster convalescence, decreased blood loss and transfusion rates, decreased postoperative pain, and shorter catheterization time.[10] However, LRP is a technically challenging procedure. Historically, the mastery of LRP required a steep learning curve with even experienced laparoscopic surgeons requiring nearly 60 cases to obtain proficiency.[11] Now that the techniques for LRP have been well developed and refined, the learning curve for the laparoscopically naïve surgeon may be shorter than once reported.[12]

The da Vinci system is a master slave surgical robot. The robot offers several advantages to the surgeon when compared to standard laparoscopy but perhaps no benefit has been more recognized than the reduction of the learning curve of the standard laparoscopic prostatectomy. Technical factors that may be attributed to shortening the learning process of RALP include a 3-dimensional visual field, 6 df from the instrument tips, the ability to filter hand tremor and an ergonomic surgical console to assist in limiting fatigue.[13] Ahlering et al described the successful transfer of skills from a laparoscopically naïve surgeon to proficiency in RALP in just 12 cases.[14] When comparing the operative times of LRP to RALP, Menon et al observed a progressive decrease in the time of RALP with surgeon experience that was not seen in the LRP group.[15]

The current study is the largest series to date comparing LRP to RALP. We did not observe a significant difference between LRP and RALP regarding operative times, operative blood loss, length of hospital stay or bladder catheterization although the blood transfusion rate was statistically higher for the RALP group. However, others who have directly compared LRP to RALP have found statistically significant differences in operative blood loss in favor of the RALP.[16,17] These studies also found a statistically significant difference between RALP and LRP with respect to operative time, transfusion rate, conversion rate, complication rate, or length of hospital stay and bladder catheterization.[16,17]

Long-term outcomes data on PSA progression are not yet available for LRP or RALP due to their relatively short existence, but encouraging short-term data are becoming available for LRP.[10] In the current series the positive margin rate was 26% and 21% for the RALP and LRP cases, respectively, across all pathological stages ($p = 0.42$). In other single institution studies directly comparing RALP to LRP no statistically significant differences were observed in the rate of positive surgical margins between the 2 groups.[16,17] In several large series comparing LRP to radical retropubic prostatectomy, no differences were observed in rates of positive surgical margins.[18]

The biggest criticism of the da Vinci system is the overall cost of the system. Cost analyses have also been performed comparing RALP to LRP.[19] An initial purchasing cost of $1.2 million is required for the da Vinci followed by a $100,000 per year maintenance fee. Lotan et al reported a cost advantage of $1,239 per case in favor of LRP when compared to RALP.[19] Menon et al estimated that an institution must perform 75 cases per year with an average operating time of 3 hours per case to be cost-effective in the United States.[16] The real question that needs to be raised is if there is no benefit to the patient with the use of the robotic system besides a shorter learning curve for the surgeon, is it fair to put added financial pressure on the healthcare system just to avoid the added training needed to overcome the learning curve of LRP?

This study is not without limitations. This is a multisurgeon comparison for the robotic and pure laparoscopic techniques. This makes our results not as reliable as if the study was performed by a single surgeon. However, we believe this does not significantly alter our results since both cohorts consisted of patients whose procedures were performed by the same multi-surgeon group at our institution. Another limitation of this current study was that it was designed to compare only operative and pathological results. Functional results were not addressed. This would be an important area to review in the future. The selection criterion for which procedure was performed is also a limitation

TABLE 3. *Intraoperative and perioperative data*

	RALP	LRP	p Value
No. lymphadenectomy (%):			
Yes	2 (1.5)	3 (2.3)	0.65
No	131 (98.5)	130 (97.7)	
No. nerve sparing (%):			
All	126 (94.7)	126 (94.7)	1.00
Bilat	91 (72.2)	96 (76.2)	
Unilat	35 (27.8)	30 (23.8)	
Mean ml blood loss (range)	609 (100–3,000)	512 (70–1,800)	0.07
Mean operative mins (range)	166 (90–300)	160 (90–270)	0.09
% Transfusion rate	3.0	9.8	0.02
Mean days (range):			
Hospital stay	5.4 (3–26)	4.9 (3–20)	0.21
Bladder catheter	9.2 (6–29)	9.0 (7–31)	0.56

TABLE 4. *Complications*

	No. RALP (%)	No. LRP (%)	Grade	Management
Anastomotic leakage	1 (0.8)	1 (0.8)	I	Longer bladder catheterization
Wound abcess	1 (0.8)	0 (0)	II	Medical
Infected pelvic hematoma	3 (2.2)	2 (1.5)	II	Medical
Urinary infection	6 (4.4)	1 (0.8)	II	Medical
Postop bleeding	6 (4.4)	1 (0.8)	II	Medical
Retention	1 (0.8)	3 (2.2)	IIIa	Foley catheterization
Anastomotic leakage	1 (0.8)	1 (0.8)	IIIa	Foley catheterization
Postop bleeding	3 (2.2)	0 (0)	IIIb	Re-intervention
Urinary sepsis	2 (1.5)	2 (1.5)	IVa	Medical
Pulmonary embolism	0 (0)	1 (0.8)	IVa	Medical
Renal insufficiency	2 (1.5)	0 (0)	IVa	Medical
Totals	26 (19.4)	12 (9.1)	p = 0.01	

of our study. The patients were not randomized into 1 of the 2 treatment arms as it was a retrospective review of our database. Patients were educated on both procedures and then decided on which technique they would prefer. The manner by which patients were assigned could have biased our findings but we believe since we had minimal input regarding the patient's decision once they were fully educated on the 2 procedures that this would only be a potential source of bias in the current study. The final limitation to this study is that it is a comparison of our initial RALP compared to pure LRP which were performed 5 years after we standardized the technique. We believe, since the initial 35 RALPs were excluded from the study and we were already proficient in the pure LRP before performing the RALP, that the 2 groups are capable of being directly compared. Comparing our first 133 initial LRPs would not serve as a fair comparison since the majority of these patients would represent the true discovery curve of the procedure which was not standardized before 1998.

CONCLUSIONS

Pure laparoscopic prostatectomy and robotic assisted prostatectomy provide good operative and postoperative results with positive margin rates equivalent to those of the open technique. We have demonstrated that the pure laparoscopic extraperitoneal radical prostatectomy in the hands of skilled laparoscopic urological surgeons at our institution is equivalent to the robotic assisted laparoscopic prostatectomy at our institution with respect to operative time, operative blood loss, hospital stay, length of bladder catheterization and positive margin rate.

TABLE 5. *Pathological data*

	RALP	LRP	p Value
No. pathological stage (%):			
pT2a	16 (12.0)	11 (8.3)	
pT2b	2 (1.5)	6 (4.5)	
pT2c	92 (69.2)	86 (64.7)	
pT3a	16 (12.0)	22 (16.5)	
pT3b	7 (5.3)	8 (6.0)	
Mean pathological Gleason score (range)	6.5 (5–9)	6.5 (5–9)	0.43
No. pos surgical margins (%):			
All	26 (19.5)	21 (15.8)	0.42
pT2a	1 (6.3)	0	0.42
pT2b	0 (0)	1 (16.7)	0.54
pT2c	22 (23.9)	15 (17.4)	0.29
pT3a	2 (12.5)	4 (18.2)	0.64
pT3b	1 (14.3)	1 (12.5)	0.92

Abbreviations and Acronyms

ASA = American Society of Anesthesiologists
BMI = body mass index
LRP = laparoscopic radical prostatectomy
PSA = prostate specific antigen
RALP = robotic assisted laparoscopic prostatectomy
RP = radical prostatectomy

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