Laparoscopic radical prostatectomy - results of 200 consecutive cases in a Canadian medical institution

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Purpose: *Since Guillonneau and Vallancien reintroduced transperitoneal laparoscopic radical prostatectomy in 1998, several other medical institutions in Europe have published their series and confirmed that laparoscopic radical prostatectomy (LRP) is a feasible and reproducible approach to the management of clinically localized prostate cancer; however, there have been few reports from North American medical institutions. We now report the results of our first 200 consecutive cases of LRP in a Canadian Medical Institution.*

Materials and method: *From February/2000 until April/2003, laparoscopic radical prostatectomy was performed on 200 out of 205 surgical candidates for radical prostatectomy. There were 120 transperitoneal laparoscopic radical prostatectomies (TP-LRP) and 80 extraperitoneal laparoscopic radical prostatectomies (EP-LRP). TP-LRP was based on posterior access to the seminal vesicles whereas EP-LRP was based on trans-bladder neck approach to the seminal vesicles. Patients' mean age was 63.5 (range 42-75). Patients were separated into two groups of 100 patients in order to assess the impact of the learning curve.*

Results: *There were 147 with pT2 disease and 53 with pT3 disease with a positive surgical margin of pT2a (0%), pT2b (20%), PT3a (52%) and pT3b (53%) respectively. The overall positive surgical margin rate is 27%. The median follow-up is 13 months. There were 111 patients available for a one-year follow-up with PSA recurrence-free rate of 95%. The positive surgical margin rates for low, intermediate and high-risk categories are 19% , 40% , and 63% respectively.*

The 6-month continence rate available in 160 patients was 88.2%. Spontaneous erection was reported in 21 out of the 46 patients (46%) with at least 6 months follow-up. The intra-operative and post-operative complication rate was 20% for Group 1 and 4% for Group 2 with an overall rate of 8%. The overall surgical time was 4.4 hours for Group 1 and 3.3 hours for Group 2. The hospital stay was 5.26 days for Group 1 and 2.44 days for Group 2. Transfusion rate was 8% for Group 1 and 2% for Group 2. The mean analgesic requirement in the last 50 cases was 5.5 mg of morphine with 58% of patients being analgesic-free post-operatively.

Conclusion: *Laparoscopic radical prostatectomy is a technically demanding procedure with a long and gradual learning curve. The present study confirms the impression of other large published series in that it appears to offer equivalent oncologic results and functional results when compared with open radical prostatectomy. The preservation of potency will require longer follow-up. Longer follow-up and large randomized control studies will be required to determine its exact role in the surgical management of clinically localized prostate cancer.*

Key Words: laparoscopy, prostatectomy, prostate cancer

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Introduction

Radical prostatectomy for treatment of clinically localized prostate cancer was first performed by Young[1]

in 1904, thus the world's first radical perineal prostatectomy. Subsequently, Millen[2] in 1947 originated radical retropubic prostatectomy and, more recently, Schuessler[3] in 1992 originated laparoscopic radical prostatectomy. Despite all these three different approaches, it was Dr. Patrick Walsh's celebrated anatomic nerve-sparing approach[4] that positioned radical prostatectomy as one of the most popular treatment options for clinically localized prostate cancer in the modern era with excellent oncologic and functional outcomes.[5] With the trend toward minimally invasive surgery over the last decade, Schuessler[6] et al first performed laparoscopic radical prostatectomy successfully in 1992 but with prolonged operating time up to 9 hours mainly due to difficult urethrovesical anastomosis from lack of sophisticated laparoscopic instrumentation at that time. However, with the rapid advances in videoscopic technology and the gradually-proven superiority of laparoscopic radical nephrectomy over its open counterpart for treatment of T1, T2 renal cell carcinoma, Guillonneau and Vallancien in 1998 revisited this procedure and overcame the technical difficulties encountered earlier. Their seminal paper "Laparoscopic Prostatectomy: The Montsouris Experience"[7] published in the Journal of Urology in 2000, has triggered great interest in many urologic communities to evaluate the laparoscopic approach.

We seek to evaluate laparoscopic radical prostatectomy beginning in February/2000 and we now report our initial experience with special emphasis on early oncologic and functional results, peri-operative morbidity and hospital economics (surgical time and hospital stay).

Materials and method

During the period of February/2000 to April/2003, 205 consecutive patients with the diagnosis of clinically localized prostate cancer who had selected surgery for their treatment were given the options of laparoscopic versus open approach.

The initial 50 or so patients were informed of the de novo nature of this procedure and the operating surgeon's experience. All but five patients selected to have laparoscopic radical prostatectomy. The charts of these 200 patients were reviewed retrospectively which forms the basis of our study. Two patients had previous open pelvic lymph node dissection before referral. One patient had a previous extravesical left ureteral re-implantation due to trauma. Ten patients had a history of previous transurethral prostatectomy. Two patients had 3 months of neo-adjuvant androgen deprivation therapy prior to surgery. Of the 200 procedures, transperitoneal laparoscopic radical prostatectomy was performed on the initial 120 cases whereas an extraperitoneal approach was used in the last 80 cases. Ninety-five percent of the patients had simultaneous pelvic lymph node dissection which we estimated to increase the OR time by about 15 minutes. Ten very obese patients in the low risk category did not undergo pelvic node dissection. All 200 procedures were performed by the same surgeon (E.T.) and assistant (R.K.).

Patient demographics are tabulated in Table 1. Their mean age is 63.5 (range 42 - 75). The mean PSA was 8.5 (range 1.3 - 100). Eighty-two percent, 15%, and 3% of the patients had a PSA of less than 10, between 10-20 and greater than 20 respectively. Seventy-four percent, 20.5%, and 5.6% of patients had clinical Stage T1c, T2a and T2b respectively. The mean Gleason score was 6.3 (range 4-9). There were 72%, 26% and 2% of patients that had Gleason score </= 6, then 7, and then 8, 9, 10 respectively. The patients were categorized into low, intermediate and high-risk categories according to Canadian consensus. The low risk category refers to patients with clinical T1c or T2a disease with a PSA of less than 10 and a Gleason score of less than or equal to 6. The intermediate risk category refers to patients with either a Gleason score 7 or PSA between 10 and 20, Clinical Stage T1c and T2a. The high-risk category refers to patients with a PSA of greater than 20, a Gleason score greater than 7 or a Clinical Stage T2b or higher. In our series 68%, 27%, and 5% of patients fit low, intermediate and high-risk categories respectively.

Pre-operative preparation

After the diagnosis of carcinoma of the prostate was made, all patients with a pre-op PSA of greater than 10 or a Gleason score of 8, 9 or 10 underwent a bone scan as part of the metastatic work-up. The night before surgery all patients receive a Fleet enema and on the day of surgery, all patients receive 5000 units of subcutaneous Heparin and 1 g of cephalosporin intravenously on call to the operating room.

Port placement

A 5 - port approach was used for both transperitoneal and extraperitoneal approach. The basic port arrangements are as follows: a 10 mm umbilical port for the laparoscope, two ports are placed on the left side of the abdomen to be used by the surgeon, a 5 mm port just medial to the left anterior superior iliac spine and a 12 mm port immediately lateral to the left rectus muscle and 2 cm caudad to the umbilical port. Two 5 mm image ports are placed on the right side to be used by the assistant.

TABLE 1. **Patient demographics**

Recruitment period	February 2000 - April 2003
Surgical candidates	205 consecutive patients
Patients' choice	laparoscopic RP 200 open RP 5
Pre-op anatomy	previous PLND (open) 2 previous open extravesical ureteral re-implantation 1 previous TUPR 10 neoadjuvant hormonal therapy (3 month) 2
Age	mean 63.5 (range 42-75)
Sample BMI (50 consecutive patients No. 141- No. 190)	mean 29 (range 22 - 39) 16/50 (33%) BMI ≥ 30
Clinical stage	T1b = 0 T1c = 148 (74%) T2a = 41 (20.5%) T2b = 11 (5.6%)
PSA	mean 8.5 (range 1.3 to 100) PSA < 10 164/200 (82%) PSA 10-20 30/200 (15%) PSA > 20 6/200 (3%)
Gleason score	mean 63 (range 4-9) ≤ 6 141/200 (72%) 51/200 (26%) 8, 9, 10 4/200 (2%)
Risk category	low 136/200 (68%) intermediate 53/200 (27%) high 11/200 (5%)

Surgical technique:

Transperitoneal approach

The technique used in transperitoneal laparoscopic prostatectomy was basically similar to that proposed by Guillonneau and Vallancien[8] with minor modifications.

To summarize:

Step 1 - Posterior dissection: The seminal vesicle and vas complex was accessed through a small transperitoneal incision in the Pouch of Douglas. During this part of the procedure, dissection must stay on the seminal vesicle to avoid any damage to the pelvic plexus and the neurovascular bundle.

Step 2 - After the seminal vesicles are mobilized, a transverse incision in the posterior Denonvilliers' fascia allows access into the prostatorectal plane and blunt dissection was used in this part of the procedure to separate the posterior surface of the prostate from the anterior surface of the rectum.

Step 3 - A transverse incision in the anterior peritoneum then allows the surgeon to enter the space of Retzius and by incising the endopelvic fascia bilaterally, the anterior surface and the lateral surface of the prostate was then mobilized. The deep dorsal vein complex was then suture ligated with #1 Dexon on a T12 needle. The cranial surface of the prostate was then dissected away from the bladder neck which was then opened first anteriorly and then posteriorly. This allowed one to expose the anterior layer of Denonvilliers' fascia and by making a transverse incision on it, re-encounter the previously-dissected seminal vesicles and vas.

Step 4 - Dissection of neurovascular bundle: By putting the seminal vesicles under traction, one exposes the lateral prostatic pedicle and the neurovascular bundle and using gentle dissection, the neurovascular bundle was then gradually pushed away from the prostatic surface. This is the most crucial part of the procedure and ultrasonic scalpels

are used to minimize thermal damage to the neurovascular bundle.

Step 5 - The deep dorsal vein complex was then transected, the apex of the prostate was identified and the membranous urethra was then transected at 2 mm distal to the apex and the prostatic specimen was then free and put on the side.

Step 6 - Urethrovesical anastomosis was carried out using two hemi-circular running sutures using 2-0 Biosyn on a T5 needle and a #20 Foley was inserted into the bladder for temporary drainage. A Jackson-Pratt drain was also left in the retropubic space to be removed on the first or second day post-op unless there is evidence of significant urinary leakage.

Extraperitoneal approach

The extraperitoneal approach began by making a 2 cm subumbilical incision and an Origin balloon dilator was inserted anterior to the posterior rectus fascia into the retropubic space. The balloon was then inflated up to 800 cc before deflation and removal. An open Hasson trocar was inserted into the subumbilical incision, the other four ports were placed similar to the transperitoneal approach.

The surgical steps of extraperitoneal laparoscopic radical prostatectomy are as follows: Mobilization of the lateral surface of the prostate by perforating the endopelvic fascia. The lateral surface of the prostate was then dissected free from the levator ani muscles. The deep dorsal vein complex was then suture ligated. Next the anterior surface of the bladder neck was dissected free from the prostate until the intra-urethral portion was identified. An incision was then made on the anterior surface of the bladder neck that was then carried circumferentially to include the posterior surface. After the bladder neck was opened circumferentially, the anterior surface of the Denonvilliers' fascia was then exposed that was then incised transversely to expose the seminal vesicle and vas complex. This complex was then mobilized completely. Care was taken to avoid damage to the pelvic plexus and the neurovascular bundle. By applying traction on the seminal vesicle, the neurovascular bundle was then further dissected away from the posterolateral surface of the prostate. Ultrasonic scalpel was used during this part of the procedure to minimize thermal damage. Following this, the deep dorsal vein complex was then transected with the monopolar cautery. The apex of the prostate was then exposed and mobilized. Care was taken to push away the neurovascular bundle which lies posterolaterally to the membranous urethra and the apex of the prostate. Following this, the prostatomembranous junction was then transected and the prostate was then dissected free and placed in an Endocatch bag. Urethrovesical anastomosis was carried out in the same fashion as in transperineal prostatectomy. A Jackson-Pratt drain was left in the retropubic space. The prostate was then extracted through the initial subumbilical incision which was then closed in routine fashion.

Post-operative course

The patient is usually started on oral feeding on the evening of surgery. The Jackson-Pratt drain is removed when the drainage is minimal. If the drainage is thought to be significant, then a spot creatinine of the Jackson-Pratt fluid is measured to rule out any significant urethrovesical leak. The urethral catheter was removed anywhere between 1-3 weeks, depending on the quality of the anastamosis as judged by the operating surgeon. In our last 100 cases, the urethral catheter was routinely removed on the 6th post-operative day without a retrograde cystogram. If the patient went into urinary retention, a urethral catheter was then placed for 72 hours and then removed. Post-operative PSA follow-up includes every four months for the first year and every six months from year two on.

Results

Open conversion

One patient required open conversion due to difficult urethrovesical anastomosis.

Oncologic results

The early oncologic results Table 2 are assessed by positive surgical margin rate of the specimen and biochemical disease free recurrence rate at one-year follow-up.

The incidence of positive surgical margin classified by risk category are 19%, 40%, and 60% for low, intermediate, and high risk categories. The positive surgical margin by pathologic stage is 18% (pT2 disease) and 52% (pT3 disease). The overall positive surgical margin rate is 27% in the series.

Analysis of specific sites of positive surgical margin revealed 69% of pT2 disease with positive margin have a positive surgical margin at the apex only, 15% have a solitary positive margin at the bladder neck only and the remaining 15% either have multiple sites or other sites.

The median follow-up is 13 months and 115

TABLE 2. **Oncologic results**

	Early 100 cases	**Late 100 cases**	**Overall**
+Surgical margin by risk category	L = 10/53 (18%) I =13/38 (34%) H =6/9 (66%) Total = 29/100 (29%)	L = 16/83 (19%) I = 8/15 (53%) H = 1/2 (50%) Total = 25/100 (25%)	L = 26/136 (19%) I = 21/53 (40%) H = 7/11 (63%) Total = 54/200 (27%) Summary: 27% + S.M. with 68% low risk disease
+Surgical margin by pathological stage	pT2 11/66 (16%) pT3 17/34 (50%)	pT2 15/81 (18.5%) pT3 11/19 (57%)	pT2 26/147 (18%) pT3 28/53 (52%)
+ Surgical margin by 1997 TNM Classification			pT2A 0/16 (0%) pT2B 26/131 (20%) pT3A 20/38 (52%) pT3B 8/15 (53%)
Site of + surgical margin for pT2 disease	Apex only 8/11 (72%) BN only 1/11 (9%) Others 2/11 (18%)	Apex only 10/15 (66%) BN Only 3/15 (20%) Others 2/15 (13%)	Apex only 18/26 (69%) BN Only 4/26 (15%) Others 4/26 (15%)
% of BN only + S.M. 2.0%			
% PSA disease free recurrence rate at 1 year f/ultrasonic available in 111 patients		106/111 (95%)	

patients have passed the 1 year mark time for follow-up. Two patients in this group were lost in follow-up. Two patients with positive surgical margin opted for immediate adjuvant radiotherapy. These four patients were excluded from the result and of the remaining 111 patients, five have a PSA recurrence defined by two consecutive readings of PSA greater than 0.2 at least 4 months apart. Thus, the biochemical disease free recurrence rate at 1 year follow-up is 95% (PSA result at 12 month follow-up).

Functional results

Table 3. The functional results are assessed in terms of the 6 month continence rate and potency rate for patients followed for a minimal of 6 months. At 6 months, the continence status of the patient is classified into dry, stress, and wet category. The patient is dry if he wears no pads or if he wears one small precautionary pad for occasional spotting. Stress incontinence is defined as one who requires one to two small pads per 24 hours. Severe incontinence is defined as one who requires more than two pads per 24 hours. In this series, 160 patients have had at least a 6 month follow-up or more and the 6 month continence rate was 88.2%. The incidence of stress incontinence and severe incontinence was 6.8% and 6% respectively. For the last 50 patients, the 2 month continence rate was 42%.

TABLE 3. **Functional results**

	Early 100 cases	**Late 100 cases**	**Overall**
6 months continence rate available in first 160 patients	dry (no pad or one precautionary pad) 88.2%	stress (soak one but < 2 pads) 6.8%	wet (≥ 2 pads) 6%
Potency (≥ 6 month f/u) 46 patients	spontaneious 17/46 (37%)	Viagra assisted 4/46 (8.6%)	Total 21/46 (46%)

Potency results

Table 3. Neurovascular bundle sparing either unilateral (4) or bilateral (42) was performed on 46 patients with at least 6 months or more follow-up. The incidence of spontaneous erection is 37%. Four additional patients achieved satisfactory intercourse with the assistance of Viagra, hence the total potency rate is 46%. This data will likely change as we extend our follow-up period.

Complication rate

Table 4. Complications that occurred within 30 days of surgery are included in this study. In the early 100 patients, seven patients developed significant anastomotic leak defined as significant Jackson-Pratt drainage, lasting more than 5 days and confirmed by biochemical study (spot creatinine of drainage fluid). One patient underwent an open re-exploration on day 9. Two patients underwent laparoscopic repair, one on day 2 and one on day 5. The patient who underwent laparoscopic repair on day 2 also developed a CVA on the evening of the second surgery followed by aspiration pneumonia and subsequent sepsis, ARDS, multiple organ failure and death on post-op day 7. This is the only death in this series. A third patient with progressively worsening urethrovesical anastomotic leak developed significant urinary extravasation into his upper thigh and underwent repeat laparoscopic anastomosis on day 5 which failed and subsequently underwent a second repair on day 10 with placement of a suprapubic catheter. The other four patients were all managed conservatively with urethral catheter drainage.

All patients who underwent redo anastomosis were early in our series. These patients would have been managed by prolonged catheterization today. There were two cases of rectal injury. One was recognized intraoperatively and was repaired laparoscopically with a two-layer closure and this patient had an uneventful recovery. The second patient, after discharge, returned to emergency on day 7 post-op with acute peritonitis due to rectourethral fistula and this patient underwent a temporary colostomy. There were two cases of ureteric injury. In one patient, both

TABLE 4. **Complications (30 day)**

	Early 100 cases	**Late 100 cases**	**Overall**
Anastomotic leak (> 5 days)	7	1	8/200 (4%)
Rectal injury	1	0	1/200 (0.5%)
Rectal-urethral fistula	1	0	1/200 (0.5%)
Ureteric injury	2	0	2/200 (1%)
Bleeding requiring re-intervention	2	0	2/200 (1%)
Ileus (> 5 days) without anastomotic leak	2	0	2/200 (1%)
DVT	1	0	1/200 (0.5%)
P.E.	0	0	0
Myocardial infarction	1	0	1/200 (0.5%)
ATN (4 to 6 day dialysis)	2	0	2/200 (1%)
Obturator nerve injury	0	1	1/200 (0.5%)
Pulmonary edema	0	1	1/200 (0.5%)
CVA with aspiration pneumonia (death)	1	0	1/200 (0.5%) mortality
Pelvic hematoma 2° anticoagulant	0	1	1/200 (0.5%)
Re-intervention	9	0	9/200 (4.5%)
Total	**20%**	**4%**	**24/200 (12%)**

ureters were clipped inadvertently during posterior mobilization of the seminal vesicles and vas. This patient's ureters were in close proximity to the seminal vesicles and they were misidentified as vascular structures and both were clipped. Post-operatively the patient developed MI in the recovery room and became anuric but renal ultrasound and CT follow-up did not demonstrate any upper tract dilatation. This patient developed signs of peritonitis on day 7 post-op and underwent laparotomy and re-implantation of both ureters. The second patient had an uneventful laparoscopic prostatectomy and was discharged in 3 days. He returned in 1 week's time with right flank pain and intravenous pyelogram revealed right hydronephrosis. Antegrade nephrostomogram revealed evidence of contrast extravasation into the pelvic cavity and this patient underwent a right ureteric re-implantation. The cause was thought to be a result of thermal necrosis of the distal ureter. Two patients required re-exploration because of bleeding. One had a small arterial bleeder along the neurovascular bundle during exploration and the second patient developed a palpable mass at the 12 mm port site and he underwent a port site exploration which revealed an epigastric artery injury. Two patients developed ileus without any radiographic evidence of anastomotic leak. One patient developed DVT 10 days post-op at home. There were two patients who developed acute transient renal failure on the second day post-op, requiring 4 and 6 days of hemodialysis before recovery. The total incidence of complications in the early 100 cases was, therefore, 20%.

There were four minor complications in the late 100 cases. One patient developed anastomotic leak which subsided after 7 days of conservative management. This patient was treated with 2 weeks of urethral catheterization before removal. One patient suffered a left obturator nerve injury during pelvic node dissection that was repaired laparoscopically with 5-0 Prolene sutures and when he was seen in 2 month follow-up, he had no clinical evidence of left abductor muscle weakness. A third patient developed pulmonary edema at the end of the procedure that responded to diuresis in the recovery room. One patient had an activated Protein V deficiency and upon the recommendation of the hematologist, he was put on full anticoagulation on day 2 post-op and he returned on day 4 with a large pelvic hematoma necessitating discontinuation of the anticoagulation. This patient was managed conservatively and he became continent at 6 months follow-up. The complication rate for the late 100 cases is 4%. The overall complication rate for both the early and late 100 cases is 12%. In addition, blood transfusion rate was 8% for the early group and 2% for the later group, with an overall rate of 5%.

TABLE 5. **Surgical time and hospital stay**

Case number	Surgical time (hours)	Hospital stay (days)
1-25	5.24	5.48
26-50	4.5	4.80
51-75	3.83	5.68
76-100	4.01	5.08
101-125	3.88	4.24
126-150	3.28	2.16
151-175	3.46	2.16
176-200	2.61	1.21
Overall (1-200)	3.85	3.8

In-hospital economics

Table 5. This is a difficult area to quantitate. Two variables, namely surgical time and hospital stay, are discussed here. The surgical time, which is defined as time from Verres needle insertion to applying the last skin staple on the skin incision, is 4.4 hours for the early 100 cases and 3.3 hours for the late 100 cases with an overall surgical time of 3.85 hours. The hospital stay is defined as the number of nights the patient spent in the hospital. The hospital stay for the early and late 100 cases was 5.26 and 2.44 respectively. The overall hospital stay rate is 3.8 days for the whole series. Table 5 provides further details on the impact of the learning curve on these two variables. As shown in Figure 1, both the surgical time and hospital stay improved dramatically in the late 100 cases.

As laparoscopic radical prostatectomy has a

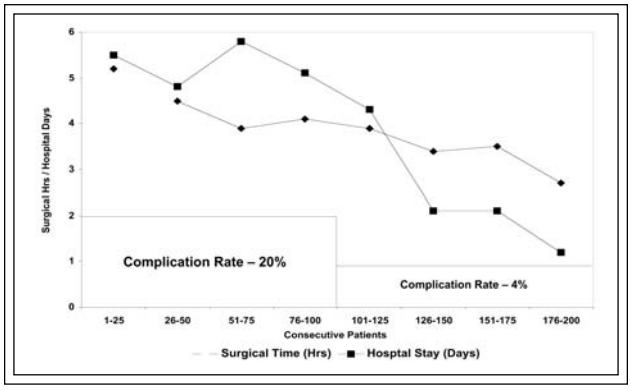

Figure 1. Learning curve effect on surgical time, hospital stay and complications

"marathon-like" learning curve, we also look at our latest 50 cases (Case 141-190). This will provide some insight of our current status on the learning curve. For these 50 consecutive patients, the average BMI is 29 with a range of 22-39. Thirty-three percent of the patients had a BMI of greater than 30. In these 50 patients, 82% of the patients had pathological pT2 disease and the positive surgical margin rate was a similar 19%. The surgical time for the last 50 cases was 3.03 hours. The hospital stay was 1.68 days. The surgical time for the last 25 cases was 2.6 hours. The hospital stay was 1.2 days. There were no transfusions and no complications. In-hospital analgesic requirement average was 5.5 mg of morphine (range 0 - 35 mg). Twenty-nine out of the 50 patients did not require any analgesic during their hospital stay. None of the patients required further analgesia at home. All patients were asked to resume full activities in 2 weeks. When they were subsequently reviewed in the office, their major complaint was the fact that they had an indwelling catheter for 6 days post-operatively. On reviewing the literature, most patients in other series had their catheter removed anywhere between 4-7 days. Because of the wide geographic distribution of patients in Southern Saskatchewan, a retrograde cystogram before catheter removal is not a practical option for most patients and, therefore, the reason why we keep our indwelling catheter in for 6 post-operative days followed by removal without any prior retrograde cystogram. In our late 100 case series, one patient developed urinary retention after the catheter was removed and he was treated with 3 days of further catheterization before second removal. A second patient developed suprapubic pain after the catheter was removed and was treated with re-insertion of a catheter. A retrograde cystogram demonstrated a small leak and this patient had a further 1 week course of indwelling catheter before removal.

Discussion

Although Walsh's anatomic nerve-sparing radical prostatectomy is the reference standard of radical prostatectomy in the modern era, Guillonneau and Vallancien in 1998 restarted the laparoscopic radical prostatectomy evaluation based on the premise that with the improved and magnified anatomic vision provided by the videoscopic technology, an opportunity exists for the urologic surgeon to perform more meticulous dissection; hence the potential for improved oncologic and functional outcome when compared with the standard open retropubic prostatectomy. In addition, in common with most of the laparoscopic procedures, laparoscopic radical prostatectomy, because of the minimally invasive nature, may offer the patient decreased peri-operative morbidity including less post-operative pain, shortened hospital stay and shortened convalescence time. During the last five years, the Montsouris experience and also experience from other European,[9-13] and American[14] centres have confirmed the feasibility and reproducibility of this procedure. We began our laparoscopic radical prostatectomy program in February/00 and since then only five patients opted for open radical prostatectomy. Ninety-five percent of the patients came from southern Saskatchewan. Our data indicated that the complication rate, surgical time and hospital stay were significantly improved in the late 100 cases when most of the radical prostatectomies were performed extraperitoneally (EP-LAP RP) compared to the early 100 cases when all of them were performed transperitoneally (TP-LAP RP). We believe the improvement is due mainly to the learning curve effect rather than due to the transperitoneal versus the extraperitoneal approach; however, two studies[15,16] comparing TP-LAP RP vs. EP-LAP RP did suggest that the extraperitoneal approach may shorten the surgical time by 30-50 minutes. The pros of transperitoneal laparoscopic radical prostatectomy include larger working space resulting in better spatialization of port sites. Better mobilization of the bladder may lead to a more tension-free urethrovesical anastomosis and the initial posterior access through the Pouch of Douglas for vas and seminal vesicle dissection when the surgical field is fresh and clean may provide better preservation of the neurovascular bundles. The pros of extraperitoneal laparoscopic radical prostatectomy include virginization of the peritoneal cavity which would avoid some degree of post-op ileus and minimize the chance of bowel injury other than the rectum. The peritoneal membrane can function as a natural bowel retractor and decrease the need for a steep Trendelenburg position during surgery. Randomized control studies comparing the learning curve effect of both procedures from surgeons with neither previous experience may provide more insight in this issue.

In our series, BMI was calculated in the last 50 patients. We have noted that one-third of the patients has a BMI of over 30 and, therefore, obesity does not appear to compromise the feasibility of the procedure Table 6. In our own experience, this group of patients may even be better served by laparoscopic prostatectomy rather than open prostatectomy because of the capability of the laparoscope to dive

TABLE 6. **Summary of latest 50 cases (140-190)**

BMI	**Mean 29 (range 22 - 39) 33%≥ 30**
% pT2	41/50 (82%)
+ S.M. pT2	8/41 (19%)
Surgical time	3.03 hours
Hospital stay	1.68 days
Transfusion	0%
Complications	0%
Analgesic (morphine)	5.5 mg (range 0-35 mg) 29/50 no analgesic requirement

deep into the operating field and, therefore, maintain the surgeon's superb anatomic visibility during the procedure. In our study, three patients had previous open retropubic surgery. These patients have increased fibrotic scarring in the retropubic space, but this did not seem to compromise the operation. In patients with previous transurethral prostatectomy, we have noted that the ureteric orifice can be in close proximity to the bladder neck and, therefore, all of our patients with a history of previous TURP had bilateral double-J stents inserted prior to surgery to help identify the ureteric orifice during bladder neck dissection (Abbou, personal communication). We have two patients who had neoadjuvant hormonal therapy. Both were encountered during our early experience when both patients underwent non-nerve-sparing radical prostatectomy. We did not notice any significant increased difficulty during these two procedures. Whether it will affect nerve sparing capability is unknown to us at this time.

Our early oncologic results were interpreted in terms of surgical margins and PSA relapse-free at 12 month follow-up which is available in 101 patients. The positive surgical margin rate was interpreted from two different aspects. By risk category, the positive surgical margin for low, intermediate and high risks groups are 19%, 40% and 63% respectively. Overall, the total positive surgical margin rate is 27%. These data are useful when we consult our patients for laparoscopic prostatectomy in the future. By pathological stage category, the positive surgical margin rate for pathological pT2 and pT3 disease are 18% and 52% respectively. For patients with a positive surgical margin in pT2 disease, 2/3 of the patients have a solitary positive margin in the apex only, suggesting further improvement in apical dissection will be needed. Possible modifications include taking 4 mm instead of 2 mm more distal than the presumed apex of the prostate which is somewhat subjective or to excise a further 2 mm rim of urethral tissue for permanent section after transecting the urethra. Whether this would compromise future continence rates or whether these techniques represent an improvement in obtaining negative apical margin deserves further study. Also from our series, only 2% of our patients have a solitary positive surgical margin at the bladder neck and this data suggests that bladder neck preservation as part of a standardized technique when performing laparoscopic RP does not appear to compromise significantly the overall surgical margin rate. The one-year PSA follow-up was available in 111 patients and this demonstrates a PSA disease-free recurrence rate of 95% and when one compares these early oncologic results with other large laparoscopic radical prostatectomy series of greater than 100 cases, Table 7 the positive overall surgical margin rate ranges from 16% - 28.2% with a mean of 22%. The positive margin rate for pT2 disease ranges from 2.3% - 27% with a mean of 17. 1%. These data are very comparable to our results.

We have 160 out of 200 patients available for a 6-month continence rate evaluation by the physician. The 6 to 12 month continence rate on the representative large laparoscopic radical prostatectomy series ranges from 72% to 92% with a mean of 84% which is similar to our result of an 88% 6 month continence rate.

As far as potency preservation is concerned, we have 46 patients with at least 6 months or more follow-up and 17 out of 46 (37%) reported spontaneous erection. In addition, 4 out of 46 (8.6%) were able to achieve sexual intercourse with Viagra (before spontaneous erection). In total, 46% of patients had return of erection after bilateral nerve-sparing laparoscopic radical prostatectomy; however, this data is immature and follow-up is too short. In addition, our neurovascular bundle-sparing technique is still in the evolving stage. For example, we have just started to perform intra-fascial neurovascular bundle sparing in properly selected patients as proposed by Guillonneau. Longer follow-up would be required to assess this important functional outcome and also its impact on surgical margin status. This issue will be addressed in our next review when we reach a patient base of 300-400 patients (better statistical power). In Montsouris recently published data of 1000 patients, neurovascular bundle preservation does not appear to pose an increased risk in positive surgical margin

rate in properly selected patients [27].

Peri-operative complications

The most common peri-operative complication is urethrovesical anastomotic leak especially during the initial learning curve. It occurred in 4% of our series with the majority of them occurring in the early 100 case group. Although three out of eight anastomotic leaks underwent early re-anastomosis, with increasing experience we have since learned that most of these patients can be treated with prolonged catheter drainage.[17] Rectal injury occurred in 1% of our patients. Both injuries occurred during posterior apical dissection; therefore, when one performs prostatorectal separation during posterior dissection, extreme care must be taken when one reaches the apex. We had two patients who suffered ureteric injury. The lesson learned is to recognize the close lateral proximity of ureter to seminal vesicles and that uncareful coagulation (especially monopolar) in this area can comprise ureteric integrity. We have recently used a trans- bladder neck approach to gain access to the seminal vesicles and we believe that this approach will largely eliminate the possibility of ureteric injury.

Last of all, we had two patients who went into post-operative transient renal failure, requiring 4 and 6 days of dialysis before complete recovery. One patient was a diabetic with an atrophic right kidney. The second patient received Toradol post-operatively and became anuric about 48 hours post-op. Although these factors may contribute to development of renal failure, we believe that prolonged renal compression by the increased intra-abdominal pressure in association with the steep Trendelenburg position were the most important contributing causes to these complications. This complication was reported only once in other laparoscopic prostatectomy series[9] and both of these events occurred in patients who underwent transperitoneal rather than extraperitoneal prostatectomy probably due to the more steep Trendelenburg position required and the prolonged OR time (early in series). Lastly, all of our major complications occurred in the first 100 cases and none have occurred in our late 100 case series and this emphasizes the demanding learning curve required. Also, as in Tables 7 and 8, our peri-operative complication rate is similar to those reported in other major laparoscopic prostatectomy series. We did not estimate our intra-operative blood loss as we find it difficult to do so in the presence of a mixture of blood, urine and irrigating fluid. However, our transfusion rate was 8% for the first 100 cases and 2% for the last 100 cases with an overall transfusion rate of 5% and that is certainly again comparable to other laparoscopic series.

In-hospital economics

As can be seen from Tables 5 and 8, our surgical time (3.85 hours) is comparable to other larger LRP series (ranges 3.61 hours to 4.51 hours). We believe that the eventual surgical time will lie between 2.5 to 3 hours. When one compares the hospital stay with other laparoscopic series, due to the different cultural and socioeconomic factors in Europe, the hospital stay appeared to be longer compared to ours. Gill et al[14]

TABLE 7. **Major complications in three laparoscopic radical prostatectomy series**

Open conversion	**Rassweiler**		**Guillonneau**		**Present study**	
	Early	**Late**	**Early**	**Late**	**Early**	**Late**
Laparotomy for bleeding	219	219	1-100	401-500	105	101-200
	2 (0.9%)	2 (0.9%)	1	0	2 (2%)	0
Rectal injury repair	3 (1.3%)	0	1 (1%)	2 (2%)	1 (1%)	0
Fistula	4 (1.8%)	3 (1.4%)			1 (1%)	
Ureteric injury	0	0	0	1 (1%)	2 (2%)	0
ATN	0	0			2 (2%)	0
Bowel injury				2 (2%)		
Pulmonary embolus	0	0			0	0
	4%	2.3%	2%	5%	8%	0
Overall	**3.15%**		**3.5%**		**4%**	

TABLE 8. **Laparoscopic radical prostatectomy data**

Lap RP	Surgical margin overall/pT2	6 month continence rate	Surgical time	Hospital stay	Transfusions	Complications	Potency
Guillonneau 2000 (France) 120	19.0/17.6	72%	3.98	10	10%	11%	9/20 (45%)
Guillonneau 2001 (France) 350	15.1/10.7	85.5% (12 mo)	3.61	6	5.7%	16.7%	59%
Abbou 2001 (France) 217	24.6/16.8	86% (12 mo)	4.6	NA	2%	NA	53%
Rassweiler 2001 (Germany) 180 1/4 Neoadjuvant therapy	16.0/2.3	74% (6 mo) 97% (12 mo)	4.51	12	31%	18.8%	4/10 (40%)
Turk 2001 (Germany) 125	26.4	92% (12 mo)	3.91	NA	3%	10.5%	26/44 (59%)
Eden 2002 (U.K.) 100	16/15	85%(6 mo) (from graph)	4.0	4.2	3%	8%	
Present Study (Canada) 2003	27/18	88% (6 mo)	3.85	3.8	5%	12%	46%
Gill 2002 (U.S.A.) 150	28.6/27	93%	4.35	1.7	NA	NA	
Overall	22%/15% range 16%-28.6% pT2 2.3%-27%	84.4%	4.10	6.28	7.4%	12.8%	

from the Cleveland Clinic reports a hospital stay of 1.7 days in his series of 150 patients which is significantly shorter than ours; however, as noted from our late 100 case group, the average hospital stay of 2.44 days is comparable.

As noted from Figure 1, our complication rate, surgical time and hospital stay are markedly improved in the late 100 case group when compared to the early 100 case group. Up to now, we still feel that our techniques are continuing to evolve. These data are a testament of a long, demanding learning curve.

As a result of maturation of our learning curve, we have recently developed a collaborative clinical pathway for laparoscopic radical prostatectomy with a target hospital stay of 1 day and a convalescence time of 2 weeks. The preliminary data suggests that patients are quite satisfied with this regime and further experience with larger series is required.

Pelvic lymphadenectomy

Although the incidence of lymph node metastasis for radical prostatectomy patients in PSA era is less than 5% in most series and Guillonneau et all in their largest LRP series of 1000 patients, PLND was performed on 21.9% of their patients (clinical T2b disease, PSA >10, Gleason score $\geq$ 4 +3),[27] we still routinely performed PLND in our LRP patients (95%) except in the "almost morbidly obese" group. This part of the procedure has very low morbidity, imposes minimal burden on surgical time (15-20 minutes) and allows safer application of Endo-GIA across the prostatic pedicle without injury to the obturator neurovascular bundle during brisk bleeding. In addition, the documentation of presence of positive lymph node metastasis will

TABLE 9. **Open radical prostatectomy data**

Open RP	PT. #	(+) ve S.M. overall/pT2	OR time	Hospital stay	Complications
Lepor 2001[18]	1000	20%/ ?			3.3%
Lepor 2003[18]	500	7.8%	2.38 hours		
Gaylis 1998[19]	116	37/17.2%	2.6 hours		5.4%
Guillonneau 2000[20]	100		2.25 hours		
Zincke[21]	3170	24%			
Rassweiler[22]	219	28.7/15.7	2.6 hours		
Cleveland[23]				3.6	
Smith[24]				2.9	
Chodak[25]				1.7	
Dillioglugil[26]	472			2.7	14.2%
Overall		**23.5/16.5**	**2.41 hours**	**2.73**	**7.6%**

provide the patient an opportunity of early androgen deprivation therapy with survival benefit. As we achieve more control of our surgical technique and the fact that none of our patients have nodal positivity, we may change our philosophy.

Comparison of laparoscopic radical prostatectomy versus open radical Prostatectomy

Tables 9 and 10 provide some of the data from contemporary open radical prostatectomy series. It is noted that the positive surgical margin rate is fairly comparable between the open and the laparoscopic group. The mean open surgical time of 2.4 hours is significantly shorter than the mean laparoscopic surgical time of 4.1 hours; however, the surgical time for the laparoscopic group is decreasing as more laparoscopic surgeons become more proficient in the procedure. The average surgical time in our last 25 cases was 2.6 hours which is very comparable to the mean open surgical time.

The hospital stay of 2.6 days in the open radical prostatectomy group including the three collaborative pathway studies is significantly less than the mean hospital stay of 6.28 days in the whole laparoscopic group but is comparable to the two North American Studies Table 7 Gill (U.S.A.) and the present series (Canada), suggesting that the difference can be due to cultural, social and economical factors. The analgesic requirement is difficult to compare as we only found data from one open radical prostatectomy

TABLE 10. **Comparison of open radical prostatectomy versus laparoscopic radical prostatectomy**

	Open RP	Laparoscopic RP	Present study (200 cases)	Present study (last 50 cases)
+ S.M. Overall / pT2	23.5%/16.5%	23.8%/17%	27%/18%	24%/19%
Surgical time (hours)	2.41 hours	4.10 hours	3.85 hours	3.03 hours
Hospital stay	2.73 days	6.28 days	3.8 days	1.68 days
Transfusion	35% (one series only)	7.4%	5%	0%
Complications	7.6%	12.8%	12%	0%
Post-operative analgesia (morphine)	50.8 mg (one study)	14.6 mg	NA	5.5 mg

TABLE 11. **Analgesic requirement**

	#	Open radical prostatectomy	Laparoscopic radical prostatectomy
Abbou (2003)	20		TP - 12.8 (0-60) EP - 6.0 (0-40)
Eden	100		20.2 (0-160)
Rassweiler (1999)	219	50.8	
Rassweiler (2002)	219		30.0
Tse (2003)	50		5.5 mg (0-30)
Overall		**50.8 (One series only)**	**14.6**

series, but our last 50 patients with an average morphine requirement of 5.5 mg. with a range of 0-30 mg. would suggest that patients undergoing laparoscopic radical prostatectomy may have substantially less analgesic requirement when compared to open radical prostatectomy; however, more accurate comparison is required before a conclusion can be drawn Table 11.

Conclusion

Laparoscopic radical prostatectomy is a technically-demanding procedure with a long and gradual learning curve. It is a procedure that is feasible and reproducible. With experience, this procedure can be performed with surgical time between 2-3 hours and equivalent early oncologic results and continence rate when compared to open radical prostatectomy. The potency preservation rate will require longer follow-up although the early results are promising. It is also a procedure that can be performed with minimal peri-operative morbidity. This procedure is now offered to our surgical candidates as a preferred option when compared to open radical prostatectomy. Because of the extremely demanding learning curve, the surgical skills, and the long surgical time required during the learning curve period, it is difficult to envision that laparoscopic radical prostatectomy will replace open radical prostatectomy in Urology practice except for a few centres with extensive laparoscopic experience until an effective teaching program exists. Further improvement in laparoscopic radical prostatectomy will come from shorter catheterization time and early return in urinary control and potency. Although a randomized controlled trial between open RP, laparoscopic RP and perineal RP is highly desirable, this is unlikely to happen in the near future. Until then, surgical candidates will be offered one of the three options, depending on the surgeon's own experience and outcome. □

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