Radical prostatectomy: a comparison of open, laparoscopic and robot-assisted laparoscopic techniques

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Introduction: *Surgical approaches to prostate cancer continue to evolve and patient demand for prostatectomy continues to increase. Technical modifications have expanded beyond open surgical approaches to include laparoscopy and more recently robotics. It is important that the enthusiasm that accompanies the introduction of new technology to surgery be accompanied by tangible benefits in terms of comparable oncological or functional outcomes and treatment morbidity.*

Materials and methods: *A literature review was performed comparing individual experiences in large clinical centers and where available comparisons within the same institute between open retropubic radical prostatectomy (RRP), laparoscopic radical prostatectomy (LRP) and robot-assisted laparoscopic radical prostatectomy (RALP).*

Results: *Mortality was extremely low for each approach, with low post-operative pain-scores and analgesic requirements. Oncological outcomes as assessed by positive surgical margin rate were comparable between RRP (13%-21%), LRP (16%-26%) and RALP (6%-23%). Differences in the manner of data accrual and definition for continence and erectile dysfunction make comparison difficult between patient series, however in single institution series comparable continence rates and time to recovery of continence have been shown.*

Conclusions: *Early data from LRP and RALP series are comparable to RRP in terms of margin-positivity and functional outcomes. Blood loss and transfusion rates appear to be lower for LRP and RALP compared to RRP, while financial costs remain higher than RRP. Long-term oncological results are keenly awaited. Ideally direct comparison between equally experienced surgeons in similar population groups will be required to demonstrate any inherent advantages or disadvantages of individual surgical approaches.*

Key Words: adenocarcinoma of prostate, radical prostatectomy, laparoscopy, robotics

Introduction

The initial description of radical prostatectomy was by Hugh Hampton Young in 1904 using a transperineal approach.[1] Retropubic radical prostatectomy (RRP) was reported by Millin in 1947.[2] While RRP gained popularity due to the familiarity of urologists with the retropubic space, there was significant morbidity in terms of blood loss, continence and potency. During the early 1980's RRP underwent a revival with increased understanding of the surgical anatomy and the pioneering work of Walsh.[3] With advances in technology, various surgical options became available including laparoscopic

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prostatectomy (LRP), first performed in 1991 and reported by Schuessler et al in 1997[4] and robot-assisted laparoscopic prostatectomy (RALP) first described by Abbou et al in 2000.[5] With the introduction of any new surgical approach there is a responsibly to compare it to accepted standards. However, in trying to draw comparisons between surgical approaches a number of biases are introduced. Different centers serve different patient populations and work within differing health systems and cultural practices. Series reporting LRP and RALP by definition have only been available since 1998 or later and thus benefited from what has been learned in the last 20 years in terms of perioperative anesthetic and surgical approaches to open prostatectomy.

The primary consideration in any new cancer operation is its ability to achieve similar or improved oncological results. Other important considerations are the associated operative risk and blood loss, peri-operative and short-term effects and more long-term consequences such as effect on continence and erectile function. Factors that will also influence the acceptance of such a treatment include cost, patient approval, how readily results can be reproduced in other centers and between different surgeons and potential future technological improvements.

Cancer control

Various indices may be used to measure oncological outcomes following prostate surgery. Ideally how each approach performs in terms of overall survival should be assessed, however given the indolent course of many untreated cancers, effects take many years to become apparent even in large studies and the results of such studies are frequently compromised by patient selection bias and cross-over of patients to other treatment modalities. An indication of outcome can be achieved by measuring biochemical progression rates, but this too will require several years of follow-up unless very aggressive malignancies are studied. A method that is readily available in the immediate post-operative period and gives a prediction as to long-term outcome is the rate of margin-positivity. However positive margin rates will vary depending on patient population and selection, and also with the technique of histopathological review being employed.

The majority of studies on open prostatectomy describe a retropubic, pre-peritoneal approach to the prostate. Prostate dissection generally involves division of the urethra distal to the prostate apex and retrograde dissection of the prostate. In contrast, the majority of centers who perform LRP describe division of the bladder neck and antegrade dissection of the prostate with notable exception of the Heilbronn series.[6] Similarly, most series on RALP describe antegrade prostate dissection through a transperitoneal approach. The decision to perform pelvic lymph node dissection and nerve preservation are dictated by PSA, Gleason score and clinical stage rather than the surgical approach in most studies. As the first laparoscopic radical prostatectomy (LRP) was reported in 1997 and the first robot-assisted laparoscopic prostatectomy (RALP) in 2000, there are no long-term survival data available and there are few results in terms of biochemical or clinical progression, so comparisons are made based on positive margin rates. Studies from academic centers report positive margin rates of 13%-21% for open surgery, 16%-27% for LRP and 6%-23% for RALP, see Tables 1-3. In comparative studies from the same center or the same surgeon, positive margin rates of 19% have been reported after RRP versus 22% for LRP[16] and 20% after RRP versus 16.7% for RALP.[17] In none of these series did differences achieve statistical significance.

Operative differences that may influence outcome include the reduced tactile sensation with laparoscopy and this has been suggested as a factor that may influence outcome in T2/T3 disease.[18] This is likely to be even more apparent in RALP. Countering this is the improved visualization and magnification available with the laparoscopic camera, particularly in the deep narrow pelvis. This is even more apparent with the laparoscope used in robotics which incorporates two overlapping cameras that combine to give the principle surgeon a three dimensional view of the surgical field.

Other means that have been suggested to improve nerve identification and tumor position and its relation to the surgical margins during LRP include the use of real-time transrectal ultrasonography. After employing this technique, Ukimura et al reported a significant reduction in positive margins from 21% to 5% in T2 disease and 57% to 18% in T3 disease.[19] Furthermore this technique facilitates prostate apical dissection and delineates the proximity of the prostate to the neurovascular bundles and rectum during surgery, see Figure 1.

Operative morbidity

Mortality associated with radical prostatectomy is low regardless of the surgical approach employed. Pain scores tend to be low with both LRP and open techniques as open prostatectomy is performed

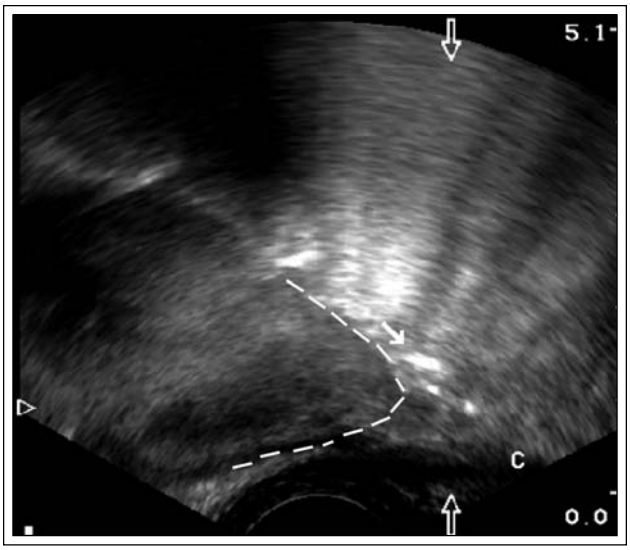

Figure 1. Intra-operative transrectal ultrasound image of prostate apex during LRP (picture courtesy of Dr. Osamu Ukimura).

through a relatively small lower abdominal incision. Though earlier retrospective reports suggested reduced analgesic requirements in LRP compared to open prostatectomy,[13] others suggest equivalent rates.[20] The use of positive pressure pneumoperitoneum is likely to reduce venous bleeding which is the main source of blood loss in radical prostatectomy. The potential for blood loss is also reduced during LRP and RALP whereby the dorsal venous complex is usually not divided until the prostate is almost completely mobilized. This is reflected in the reported lower rates of blood loss and transfusion requirements in LRP and RALP series, see Tables 1-3. Convalescence times post radical prostatectomy vary considerably and are influenced by local practices and expectations. Traditionally open prostatectomy series were described with catheter duration of 2-3 weeks.[21] More recent series describe typical catheter duration of 7-10 days, see Table 1. In laparoscopic series typical duration of catheterization are of the order of 5-7 days in the majority of patients, see Table 2. Catheter duration of 2-4 days have been described post-LRP albeit with a rate of urinary retention of 11% following early catheter removal.[22] Duration of catheterization with robotics is similar to that seen following LRP, see Table 3.

Continence

Considerable differences may exist between definitions of continence and also the means by which continence information is obtained. Reported continence rates (typically at 1 year and defined as requiring one or no pad per day) following RRP of 91%-93%, LRP of 82%-96% and RALP of 81%-96% are shown in Tables 1-3. Perhaps the best available data are those from comparative series from single centers. Though bias may exist in these studies with regard to patient selection and surgical experience with different surgical approaches, such comparative studies generally employ the same definitions of continence and means of obtaining patient information from different treatment groups. In comparing laparoscopic and open prostatectomy, both show similar return of diurnal continence with a trend toward (though not statistically significant) nocturnal continence being better in the LRP group.[23]

Erectile dysfunction

Erectile dysfunction outcomes after radical prostatectomy also display considerable variations between reported series i.e. outcomes differ depending on whether they are physician or patient reported, interview or anonymous questionnaire based and also on the definition of potency used. Particular differences occur between reporting full potency or potency with the use of oral or injectible agents. Potency rates following open surgery are reported as 46%-67%, 46%-74% following LRP and 38%-64% following RALP, see Tables 1-3. Single-institution reports demonstrate similar return of erectile function at 3, 6 and 12 months following open prostatectomy and LRP.[23]

Expense

In studies comparing open and laparoscopic surgery, higher laparoscopic costs are minimized with increasing experience in laparoscopy resulting in shorter operative times and shorter hospital stay.[24,25] Cost of RALP remains 20%-30% greater than the cost of open surgery.[24] Cost differences may be even more pronounced between different health systems. Contrary to the findings of most American studies, estimates from France show that LRP represents a 20% saving over RRP.[26] As the surgical volume increases, the cost differential for RALP versus RRP is reduced with cost equivalence estimated for 14 cases per week.[27] It is also reasonable to assume, as with most evolving technologies, that expense will reduce with technological advancements.

Reproducibility of technique

RRP has been adopted and successfully performed by surgeons worldwide. The spread of laparoscopy

TABLE 1. **Open radical prostatectomy series**

Institution	# Patients	OR time (min)	EBL (cc)	Duration catheter (days)	Duration of stay (days)	Complication rate %	Positive margin %	Continence (<1 pad/day)	Erectile function
Vanderbilt (Smith et al)[7]	124	129	579	na	3.0	na	na	na	na
New York University (Lepor et al)[8]	1024	131	820	7-10	2.4	6.6	21	91%	46%
Washington University (Catalona et al)[9]	1870	217	1395	7-10	na	10	21	92%	67%

TABLE 2. **Laparoscopic radical prostatectomy series**

Institution	# Patients	OR time (min)	EBL (cc)	Duration catheter (days)	Duration of stay (days)	Complication rate %	Positive margin %	Continence (<1 pad/day)	Erectile function
Montsouris (Guillonneau et al)[10]	550	200	380	4.2	5	3.6	16.7	82.3%	66%
Créteil (Abbou et al)[11]	134	240		4.8	6.1	9	25	86.2%	46% (w/o sildenafil)
Berlin (Turk et al)[12]	125	265	185	12	8	14	26.4	92%	59%
Heilbronn (Rassweiler et al)[13]	438	218	800	7	11	10	23.7	95.8%	na
Cleveland Clinic (2003-3/05)	400	232	280	8.3	1.8	2	20.3	92%	74%

TABLE 3. **Robot-assisted laparoscopic prostatectomy series**

Group	# Patients	OR time (min)	EBL (cc)	Duration catheter (days)	Duration of stay (days)	Complication rate %	Positive margin %	Continence (<1 pad/day)	Erectile function
Henry Ford (Menon et al)[14]	200	160	152	7	1.2	5	6	96%	38%-64%
UC Irvine (Ahlering et al)[15]	140	231	102	7	1-7	na	16.7-36	73%-81%	na
Cleveland Clinic (6/02-4/05)	102	210	213	6	1-3	2	23	94%	na

has been slower, perhaps entailed with the long learning curve which has variously been estimated at between 50 and 200 cases.[26,28] Estimates to attain proficiency in robot-assisted lapaparoscopic prostatectomy for a surgeon experience in RRP have been estimated to be between 10 and 100 cases.[17,29] This may contribute to the widespread uptake as it means that minimally invasive surgery is more accessible to an increasing number of surgeons. While applicable to open surgery, LRP and LARP are more amenable to video teaching, practice of techniques in dry lab, wet lab and virtual trainers as well as affording a clear surgical view for both the trainee and mentor during proctoring.

Conclusions

Comparisons between surgical techniques are fraught with difficulties, especially with the lack of prospective randomized trials comparing various surgical approaches. Most reports relate to results from a single surgical center with one surgical approach predominating. While such studies are informative, outcomes are difficult to compare with those from other centers. Allowing for these shortcomings, a number of conclusions can still be drawn from the available data reported. Early oncological results following LRP and RALP are comparable to those of open surgery in terms of surgical margins while long-term biochemical and disease-free survival results are awaited. LRP and RARP are associated with a significantly lower blood loss and lower transfusion rates compared to open surgery. Pain scores and analgesic requirements are low and patients have early return to full activity with all three prostatectomy approaches. Functional outcomes in terms of return of urinary continence are impressive with all three techniques. Robotic surgery remains significantly more expensive, though cost differential does decrease with increased patient throughput. Surgical techniques are subject to ongoing improvement, but the greatest potential lies with minimally invasive techniques, where the scope for instrument development is still great. Patient acceptance for radical prostatectomy is high as witnessed by the tremendous increase in demand, particularly for RALP. We must strive to determine that this interest is well founded by determining that treatments achieve equivalent or in some ways superior results in terms of oncological control, peri-operative morbidity and long-term functional outcomes. □

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