LAPAROSCOPIC RADICAL PROSTATECTOMY IN THE ERA OF ROBOT-ASSISTED TECHNOLOGY

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ABSTRACT

In this work the outcomes of laparoscopic radical prostatectomy (LRP) with regard to perioperative morbidity, oncological effectiveness, as well as postoperative continence and potency preservation are being reviewed and compared with the gold standard open radical prostatectomy. In addition, the limitations of LRP are being presented in contrast to the advancement offered by the emerging robotic assisted radical prostatectomy in an attempt to reveal whether laparoscopic approach still has a role in the era of robot-assisted technology.

Keywords: Laparoscopic, radical, prostatectomy, prostate, cancer.

INTRODUCTION

Prostate cancer is the most frequently newly-diagnosed cancer and the third most common cause of male cancer-specific mortality in Europe.[1] Numerous different types of treatments against this neoplasia are available today, offering long-term survival in the vast majority of patients. Among them, radical prostatectomy - performed either via open surgery, laparoscopically, or under robotic assistance - is considered the mainstay in the management of localised and locally advanced prostate cancer.[2] Laparoscopic radical prostatectomy (LRP) was first introduced in 1997 by Shuessler et al.[3] but further modifications over the original technique by Guillonneau et al.[4] were deemed necessary before the acceptance of the technique worldwide. In this work, the outcomes of LRP with regard to perioperative morbidity, oncological effectiveness as well as postoperative continence, and potency preservation are being reviewed and compared with the gold-standard open radical prostatectomy (ORP). In addition, the limitations of LRP are being presented in contrast to the advancement offered by the emerging robotic-assisted radical prostatectomy (RARP) in an attempt to reveal whether laparoscopic approach still has a role in the era of robot-assisted technology.

OUTCOMES

Perioperative Outcomes

LRP is considered a minimally invasive surgical treatment option in the management of prostate cancer given that the procedure has been associated with minimum perioperative morbidity, short hospitalisation, and early recovery by the majority of reporting literature (Table 1).

Decreased intraoperative blood loss as compared with ORP is one of the fundamental benefits of the laparoscopic procedure, since CO_2 insufflation pressure diminishes venous bleeding and allows the accomplishment of the procedure in a relatively bloodless field. Touijer and colleagues,[5] in a prospective non-randomised study including 612 patients subjected to LRP and 818 subjected to ORP, documented that laparoscopy was

Table 1: Perioperative outcomes of laparoscopic radical prostatectomy.

Author	Type of Study	Comparative groups	Operative Time
Touijer[5]	Prospective non randomised	612 LRP versus 818 ORP	• Lower blood loss and transfusion rates
Coelho[6]	Meta-analysis of data from high volume centres	ORP, LRP, RARP	• Similar complications rates with ORP and RARP • Lower blood loss and transfusion rates than ORP
Tewari[7]	Meta-analysis	ORP, LRP, RARP	• Lower blood loss, transfusion rates, and hospitalisation than ORP • Low intraoperative complication rates • Similar perioperative complication rates with ORP but higher than RARP • Similar readmission rates with ORP but higher than RARP
Sugihara[8]	Propensity-score matching analysis	1627 LRP and ORP propensity-score matched pairs	• Better complication rates • Lower transfusion rates • Shorter hospitalisation • Longer operative time
Liu[9]	Retrospective review of a prospective database	4036 LRP and 1283 ORP	• Longer operative time • Lower transfusions • Lower hospitalisation • Lower perioperative complication rates and mortality
Caras[11]	Retrospective review of a nationwide database	8391 LRP versus 2278 ORP	• Lower morbidity, surgical site infections, mortality, wound disruption, urinary tract infection, bleeding, and sepsis or septic shock

ORP: open radical prostatectomy; LRP: laparoscopic radical prostatectomy; RARP: robotic assisted radical prostatectomy.

associated with less blood loss and a lower transfusion rate than ORP (315 versus 1,267 ml and 3% versus 49% accordingly). Similarly, a weighted mean of perioperative transfusion in 3.5% of LSP cases versus 20.1% after ORP was calculated in a large meta-analysis of data reported by high-volume centres.[6] Accordingly, a more recent systematic review verified the superiority of endoscopic techniques in terms of blood loss over open approach.[7]

Patients subjected to LRP can be discharged as soon as the drain has been removed and bowel function has returned, usually after the second postoperative day. However, reported LRP hospitalisation varies greatly among studies given that different departments entail different rehabilitation protocols. In general, in many institutes - especially in Europe - patients remain hospitalised until the urethrovesical anastomosis is tested by cystography and the catheter is removed (usually between the fifth and seventh postoperative day). In contrast, US patients are regularly discharged from hospital soon after surgery and return after a few days to remove the urinary catheter. Despite the abovementioned heterogeneity of LSP hospitalisation reports, the procedure has been associated with shorter hospital stay than open prostatectomy as documented by several nationwide radical prostatectomy databases reporting data from both techniques.[8,9] The latter is not only due to minimal perioperative blood loss after LRP, but also due to the minimisation of abdominal trauma that is responsible for a reduced postoperative pain and a rapid recovery. Pushing the envelope further in an attempt to decrease hospital cost, LRP has been performed even as a day case, without overnight stay, with an uneventful course.[10]

With regard to perioperative morbidity, LRP has been associated with decreased complications

compared with open prostatectomy. A recent analysis of the American College of Surgeons national, risk-adjusted surgical database (including data from 10,669 prostatectomies) revealed decreased incidence of overall and serious morbidity, mortality, surgical site complications, urinary tract infection, bleeding, and septic events for laparoscopy as compared with ORP.[11] In addition, a favourable overall complication rate for LRP was documented in an analysis based on the Japanese Diagnosis Procedure Combination database. Authors matched 1,627 LRP with a similar number of propensity-score matched ORP procedures, and found that the laparoscopic approach showed a better overall complication rate (3.4% versus 5.0%).[8]

Oncological Outcomes

Radical prostatectomy is an oncological operation performed with the intention to cure prostatic cancer. It is currently indicated only for cases of localised disease, where prostatic excision would offer complete tumour removal, and accordingly evidence of local or distal metastasis presents a contraindication for the approach. Positive surgical margins (PSM) in an excised specimen is an indicator that the radicality of tumour excision was not achieved, and indeed PSM has been clearly associated with an increased risk of future biochemical recurrence (BCR), local disease progression, and also the need for secondary cancer treatment.[12]

A significant variation of PSM rates among LRP literature is present mainly due to the fact that PSM rates in radical prostatectomy specimens are dependent on several factors, including the pathological stage of the disease, the surgeon's experience, and the quality of pathologic assessment.[13,14] A variation of PSM between 7-22% for pT2 and 26-55% for pT3 disease has been reported by high-volume centres, while no differences in overall PSM between LRP and ORP was evidenced in a cumulative analysis of comparative studies between the two techniques.[6,15]

The excellent long-term oncological effectiveness of LRP has been well documented in several studies with follow-up of more than 10 years (Table 2). Busch et al.,[16] in one of the largest LRP series (1,845 cases) with a mean follow-up of 5 years and patients followed-up to 11.3 years, reported that 5-year, 8-year, and 10-year overall BCR-free survival rates were 83.9%, 78.6%, and 75.6%, respectively. Similarly, Hruza et al.,[17] in one of the most recent reports on long-term oncological outcomes of LRP, reported that BCR-free survival rates at 10 years postoperatively for pT2, pT3a, and pT3b/4 staged patients were 80.2%, 47.4%, and 49.8%, respectively. In addition, the 10-year clinical progression-free survival rates were 97.2% (pT2), 84.4% (pT3a), and 78.1% (pT3b/4).

Functional Outcomes

Lack of standardisation in continence report after radical prostatectomy (most studies use no validated institutional questionnaires) renders comparative assessment of continence between studies very difficult.[18] Still, the wide accumulative experience with LRP has clearly indicated that the laparoscopic approach demonstrates excellent continence rates, equivalent with the open approach.[15] At 12 months, following LRP, continence rates ranging between 82-95% have been reported by high-volume centres with a trend for further improvement up to 97% at >18 months postoperatively.[6] Significant incontinence, defined as patients needing more than two pads per day, is reported in 1.3-6% of patients subjected to LRP as documented by centres using validated continence questionnaires.[19,20]

Potency is considered one of the most complicated parameters to assess the surgical quality of a particular radical prostatectomy technique. Many non-surgical independent factors such as age, preoperative erectile status, presence of comorbidities, emotional status, presence of partner, and others contribute significantly to the recovery of potency. In addition, assessment of postoperative erectile function is somewhat subjective as it is based on the patient's self-assessment, while different potency definitions are regularly used between studies. Accordingly, differences in potency reported by different studies could reflect not only differences on the quality of nerve sparing technique but also variations in baseline characteristics of studied populations and potency definition.

With all the above limitations of postoperative erectile function assessment taken into consideration, studies reporting potency rates after LRP demonstrate a wide variability of 32-85%.[21] Still, accumulative evidence has rendered the procedure equivalent to ORP in patients subjected to nerve sparing surgery.

Table 2: Oncological outcomes of laparoscopic radical prostatectomy.

Author	Type of Study	Outcome of LRP
Coelho[6]	Meta-analysis of data from high volume centres	• PSMs 12.4% for pT2 and 39.2% for pT3 disease • Similar PSM with ORP but higher than RARP
Ficarra[15]	Meta-analysis of comparative studies	• Similar oncologic outcomes with ORP and RARP
Busch[16]	Retrospective cohort	• 29.2% overall PSM • 5-year, 8-year, and 10-year BCR-free survival rates were 83.9%, 78.6%, and 75.6%, respectively
Hruza[17]	Retrospective review of a prospective database	• BCR-free survival rates at 10 years were 80.2%, 47.4%, and 49.8% in patients staged pT2, pT3a, and pT3b/4, accordingly

PSM: positive surgical margins; BCR: biochemical recurrence; ORP: open radical prostatectomy; LRP: laparoscopic radical prostatectomy; RARP: robotic assisted radical prostatectomy.

Table 3: Functional outcomes of laparoscopic radical prostatectomy.

Author	Type of Study	Outcome of LRP
Coelho[6]	Meta-analysis of data from high-volume centres	• 84.8% continence at 12 months • 54% potency for BNS
Ficarra[15]	Meta-analysis of comparative studies	• LRP and ORP showed similar continence and potency rates • No significant differences with RARP
Stolzenburg[19]	Retrospective cohort	• 94.7% continence at 12 months • 84.9% potency at 12 months for BNS
Guillonneau[20]	Retrospective review of a prospective database	• 82.3% continence at 12 months • 85% of pts <70 years recovered spontaneous erections
Kilminster[22]	Meta-analysis using only data obtained from potent men before surgery	• 58-74% potency at 48 months

BNS: bilateral nerve sparing; ORP: open radical prostatectomy; LRP: laparoscopic radical prostatectomy; RARP: robotic assisted radical prostatectomy.

Kilminster et al.,[22] in a cumulative meta-analysis of studies reporting erectile function in preoperatively potent patients, calculated a similar cumulative range of potency rates after LRP versus ORP at 48 months (58-74% versus 49-74% accordingly). Selected literature reporting functional outcomes after LRP are presented in Table 3.

Pentafecta Outcome of LRP

Being a major oncological reconstructive urological operation, the three main goals of radical prostatectomy in order of importance are: to cure cancer, to maintain urinary continence, and to preserve potency. The term 'trifecta' was introduced to report the concomitant meeting of all these three parameters (a continent and potent patient with no BCR). To better address the ideal radical prostatectomy operation, two additional perioperative variables - the lack of complications and the negative surgical margins on surgical specimen - were added to the trifecta to form the 'pentafecta'. Good et al.[23] reported that, following a long learning curve of more than 250 operations, pentafecta could be achieved in up to 63% of LRP patients. Similarly, Si-Tu et al.[24] reported a 73% pentafecta outcome 60 months after LRP. In contrast, Asimakopoulos et al.[25] reported that out of 91 prospectively-followed LRP patients only

25 (27%) met the pentafecta. The majority (80%) of reported cases lost the pentafecta goal only due to missing potency recovery.

THE STIFF LEARNING CURVE OF LRP

As evidenced from above, LRP offers equivalent oncological and functional outcomes with ORP in the setting of minimally invasive surgery. Still, LRP has a major drawback which is the presence of a demanding and stiff learning curve with a significant impact on perioperative, functional, and oncological outcomes. The surgeon must perform a difficult reconstructive operation in a virtual two-dimensional environment, using instruments with restricted degrees of freedom, confronting a notable physical fatigue as a result of longer operating times and defective ergonomy. Hruza et al.,[26] analysing 2,200 consecutive patients who underwent LRP at a single institution, reported that first generation surgeons with a vast open surgical experience required 700 cases to reach a plateau in complication rates. Of notice, third generation surgeons reached the same plateau earlier, at 250 cases. In terms of PSM, Secin et al.[27] revealed that there was an apparent improvement in PSM rates up to a plateau at 200-250 surgeries. Once this plateau was reached, changes in PSM rates were relatively minimal. In contrast, Vickers et al.[28] reported a significant improvement in PSM rates even after 250 cases, demonstrating that for a patient treated by a surgeon with experience of 250 and 750 previous LRPs, the 5-year risk of BCR decreased from 16% to 9%, accordingly. Conclusively, significant training is required for a surgeon to achieve a basic level of competency to safely perform LRP and a long-lasting learning curve to provide optimum oncological outcomes.

ROBOT-ASSISTED SURGERY

The Fast and Widespread Diffusion of Robotic-Assisted Radical Prostatectomy

In contrast to laparoscopy, in the case of robotic-assisted surgery the efficient translation of human hand motion into robotic arm movement and the three-dimensional vision allows a rapid integration of open surgical experience to robotic-assisted surgery. Sejima et al.,[29] during the introduction of robotic technology to radical prostatectomy operations in their department, used a RARP termination protocol, which was applied when there was excessive bleeding or surgical time. Based on the above criteria, no conversion to open surgery was deemed necessary during the first 100 cases. In addition to improved safety, even from the initial cases, long-term oncological data of RARP became available and demonstrated that the robotic assistance does not compromise the oncological effectiveness and functional outcomes of radical prostatectomy.

According to the recent European Association of Urology (EAU) guidelines on robotic surgery, RARP offers a long BCR-free survival equivalent to the other radical prostatectomy approaches in addition to not-inferior continence and potency rates. Furthermore, a trend towards faster recovery of potency and continence becomes evident as cumulative data are maturing.[30] This explains why RARP has gained significant popularity. Obviously, being competent to safely perform a RARP does not mean that a surgeon has reached the end of the learning curve, and in accordance to the other radical prostatectomy approaches, a long-lasting learning curve exists for robotic-assisted approach as well.[31] Still, robotic surgery is considered easier to master than laparoscopy, and once mastered is definitely more comfortable for the surgeon.

Taking the above into consideration, in expert hands LRP and RARP are at least comparable in terms of oncological and functional effectiveness, however, significant differences still exist in required learning curve and surgeon's fatigue during surgery in favour of robotic approach.

Role of LRP in the Era of Robot-Assisted Technology

Currently available robotic technology is expensive and becomes cost-effective only by the centralisation of care in high-volume centres in Western countries.[32] Until robotic technology prices drop - due to industrial competition or the availability of cheaper robots - laparoscopy will remain the only minimally invasive surgical treatment option for the majority of worldwide prostate cancer patients. In addition, laparoscopic instrumentation is constantly evolving to address the limitations of laparoscopy. Three-dimensional laparoscopes are available today offering stereoscopic view in conventional laparoscopic surgery. In addition, articulating laparoscopic instruments increase the degrees of freedom, diminish instrument classing, and facilitate intracorporeal suturing. Using this novel technology the learning curve of laparoscopy

is expected to be reduced and its worldwide adaptation to increase. Finally, particular concepts reducing morbidity in laparoscopic surgery cannot be integrated by current robotic technology. Miniaturising laparoscopic instruments is a trend in laparoscopy aiming to reduce abdominal trauma and scar formation caused by laparoscopic trocar insertion. The so-called 'needlescopic' or 'mini-laparoscopic' surgery uses 3-4 mm laparoscopic instruments (solely or in combination with conventional or multiport trocar devices), providing a scarless result (given that 3-4 mm incisions do not require official suturing). Current robotic arm technology is too large to fit into the mini-laparoscopic setting, which can be utilised only via the conventional laparoscopic approach.

COST OF LRP

It is not the purpose of this work to discuss the cost of LRP given that data on the subject are of low quality (lack of randomised comparative studies) and significant variations of cost estimations exist among different studies, different countries, and different departments. Generally, the cost of LRP is considered more than ORP due to the added expenses associated with the cost of disposable laparoscopic equipment. Still, it should be mentioned that at least part of this added cost is equated by the reduced hospitalisation and morbidity of the laparoscopic approach. In contrast, LRP is considered less expensive than robotic-assisted surgery mainly due to the fixed capital and maintenance charges for the robotic system.[33]

CONCLUSION

In conclusion, a wealth of high quality data have documented that LRP is a surgical approach offering favourable oncological and functional outcomes with minimum morbidity. When compared to RARP, the conventional laparoscopic approach demonstrates equivalent safety and efficacy, yet with a longer learning curve and a restricted ergonomy during operation. Still laparoscopy is more cost-effective than RARP and available worldwide. Integration of novel laparoscopic instruments in LRP can address the majority of laparoscopic drawbacks and further increase its adaptation in the urological community.

REFERENCES

1. Ferlay J et al. Cancer incidence and mortality patterns in Europe: estimates for 40 countries in 2012. Eur J Cancer. 2013;49(6):1374-403.

2. Heidenreich A et al. EAU guidelines on prostate cancer. Part 1: screening, diagnosis, and treatment of clinically localised disease. Eur Urol. 2011;59(1):61-71.

3. Schuessler WW et al. Laparoscopic radical prostatectomy: initial short-term experience. Urology. 1997;50(6):854-7.

4. Guillonneau B et al. Laparoscopic radical prostatectomy: technical and early oncological assessment of 40 operations. Eur Urol. 1999;36:14-20.

5. Touijer K et al. Comprehensive prospective comparative analysis of outcomes between open and laparoscopic radical prostatectomy conducted in 2003 to 2005. J Urol. 2008;179(5):1811–7.

6. Coelho RF et al. Retropubic, laparoscopic, and robot-assisted radical prostatectomy: a critical review of outcomes reported by high-volume centers. J Endourol. 2010;24(12):2003-15.

7. Tewari A et al. Positive surgical margin and perioperative complication rates of primary surgical treatments for prostate cancer: a systematic review and meta-analysis comparing retropubic, laparoscopic, and robotic prostatectomy. Eur Urol. 2012;62(1):1-15.

8. Sugihara T et al. Comparisons of perioperative outcomes and costs between open and laparoscopic radical prostatectomy: a propensity-score matching analysis based on the Japanese Diagnosis Procedure Combination database. Int J Urol. 2013;20(3):349-53.

9. Liu JJ et al. Perioperative outcomes for laparoscopic and robotic compared with open prostatectomy using the National Surgical Quality Improvement Program (NSQIP) database. Urology. 2013;82(3):579-83.

10. Dudderidge TJ et al. Evolution of care pathway for laparoscopic radical prostatectomy. J Endourol. 2012;26(6):660-5.

11. Caras RJ et al. Laparoscopic Radical Prostatectomy Demonstrates Less Morbidity Than Open Radical Prostatectomy: An Analysis of the American College of Surgeons-National Surgical Quality Improvement Program Database with a Focus on Surgical Trainee Involvement. J Endourol. 2013. [Epub ahead of print].

12. Yossepowitch O et al. Positive surgical margins in radical prostatectomy: outlining the problem and its long-term consequences. Eur Urol. 2009;55(1):87-99.

13. Secin F et al. The Learning Curve for Laparoscopic Radical Prostatectomy: An International Multicenter Study. J Urol. 2010;184(6):2291–6.

14. Fontenot PA, Mansour AM. Reporting positive surgical margins after radical prostatectomy: time for standardization. BJU Int. 2013;111(8):E290-9.

15. Ficarra V et al. Retropubic, laparoscopic, and robot assisted radical prostatectomy: a systematic review and cumulative analysis of comparative studies. Eur Urol. 2009;55(5):1037-63.

16. Busch J et al. Long-term oncological and continence outcomes after laparoscopic radical prostatectomy: a single-centre experience. BJU Int. 2012;110(11 Pt C):E985-90.

17. Hruza M et al. Long-term oncological outcomes after laparoscopic radical prostatectomy. BJU Int. 2013;111(2):271-80.

18. Touijer K, Guillonneau B. Laparoscopic radical prostatectomy: a critical analysis of surgical quality. Eur Urol. 2006;49(4):625-32.

19. Stolzenburg JU et al. Endoscopic

extraperitoneal radical prostatectomy: evolution of the technique and experience with 2400 cases. J Endourol. 2009;23(9):1467-72.

20. Guillonneau B et al. Laparoscopic radical prostatectomy: assessment after 550 procedures. Crit Rev Oncol Hematol. 2002;43(2):123-33.

21. Ferronha F et al. Is there any evidence of superiority between retropubic, laparoscopic or robot-assisted radical prostatectomy? Int Braz J Urol. 2011;37(2):146-58.

22. Kilminster S et al. Predicting erectile function outcome in men after radical prostatectomy for prostate cancer. BJU Int. 2012;110(3):422-6.

23. Good DW et al. Analysis of the pentafecta learning curve for laparoscopic radical prostatectomy. World J Urol. 2013. [Epub ahead of print].

24. Si-Tu J et al. Prospective evaluation of pentafecta outcomes at 5 years after laparoscopic radical prostatectomy: results of 170 patients at a single center. Neoplasma. 2013;60(3):309-14.

25. Asimakopoulos AD et al. Laparoscopic versus robot-assisted bilateral nerve-sparing radical prostatectomy: comparison of pentafecta rates for a single surgeon. Surg Endosc. 2013;27(11):4297-304.

26. Hruza M et al. Complications in 2200 consecutive laparoscopic radical prostatectomies: standardised evaluation and analysis of learning curves. Eur Urol. 2010;58(5):733-41.

27. Secin FP et al. The learning curve for laparoscopic radical prostatectomy: an international multicenter study. J Urol. 2010;184(6):2291-6.

28. Vickers AJ et al. The surgical learning curve for laparoscopic radical prostatectomy: a retrospective cohort study. Lancet Oncol. 2009;10(5):475-80.

29. Sejima T et al. Robot-assisted radical prostatectomy: a case series of the first 100 patients constitutional introduction and implementation on the basis of comprehensive department of minimal invasive surgery center. BMC Res Notes. 2013;6:436.

30. Merseburger AS et al. EAU guidelines on robotic and single-site surgery in urology. Eur Urol. 2013;64(2):277-91.

31. Mirheydar HS, Parsons JK. Diffusion of robotics into clinical practice in the United States: process, patient safety, learning curves, and the public health. World J Urol. 2013;31(3):455-61.

32. Stitzenberg KB et al. Trends in radical prostatectomy: centralization, robotics, and access to urologic cancer care. Cancer. 2012;118(1):54-62.

33. Ramsay et al. Systematic review and economic modelling of the relative clinical benefit and cost-effectiveness of laparoscopic surgery and robotic surgery for removal of the prostate in men with localised prostate cancer. Health Technol Assess. 2012;16(41):1-313.