

Recent Advances in Robot-Assisted Laparoscopic Prostatectomy

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Abstract

Introduction: Ever since the first RALP was performed in May 2000, the robotic approach has surpassed the expectations with >80% of prostatectomies in the United States being performed using the robot. Other than technical advances taking place with the robotic machine and the robotic instruments, there have been massive strides in the improvement of the technique. Better understanding of the anatomy of the neurovascular bundles and also the improvements in the imaging technology has impacted on the way the procedure is performed. This review looks into the developments that have taken place over the last three years.

Materials and methods: Articles pertaining to robot assisted laparoscopic prostatectomy published over the last three years were extracted from PUBMED and analysed. Those articles that have impacted on the clinical practice were reviewed.

Results: Recently, the concept of incremental nerve sparing techniques has emerged. Two leading authorities have classified the degree of nerve sparing based on visual cues and have demonstrated its impact on functional and oncological outcomes. Another technical modification to the procedure has been in inserting a supra-pubic catheter. This has been shown to improve the quality of life of patients by avoiding a per-urethral catheter without any negative impact on continence or increased risk of bladder neck contracture. Previously, nerve sparing was correlated with erectile function. However, recent studies have highlighted that nerve preservation has also an impact on the continence rates. Randomized control trials have now demonstrated the superiority of barbed sutures over the conventional monofilament sutures. Image guided surgery is making its way into RALP and more research in this field will aid in better oncological control with minimal sacrifice of important structures around the prostate.

Conclusion: Advances in surgical techniques are resulting in better functional and oncological outcomes. This has a direct impact in improving the quality of life for the patients. More research into application of emerging technology such as integration of image-guided surgery will herald better outcomes in the near future.

Introduction

Radical prostatectomy is a recognized standard treatment option for localized prostate cancer with indications gradually increasing to a subset of patients presenting with locally advanced prostate cancer. Open radical prostatectomy (ORP) was challenged in the 90s by laparoscopic radical prostatectomy (LRP), with the advantage of less blood loss, early recovery and better cosmesis. LRP was soon challenged by Robot-assisted laparoscopic prostatectomy at the dawn of the 21st century. Ever since the first RALP was performed in May 2000, the robotic approach has surpassed expectation with >80% of prostatectomies in the US being performed using the robot. Other than technical advances taking place with the robotic machine and the robotic instruments, there have been massive strides in the development of the surgical technique. This review is to look into the developments that have taken place over the last three years.

Materials and Methods

Articles pertaining to robot assisted laparoscopic prostatectomy published over the last three years were extracted from PUBMED and analysed. Those articles that have impacted on the clinical practice were reviewed.

Results and Discussion

The following advances have taken place and described in brief.

Degrees of nerve sparing RALP

Dr Mani Menon from Henry Ford Hospital in Detroit described the 'Veil of Aphrodite' technique of RALP, suggesting that there variable distribution of neurovascular bundles on the lateral fascia of the prostate

[1]. This led to technical refinements and over the last two years, with two leading authorities describing "incremental degrees" of nerve sparing techniques. Dr A. Tiwari described the Anatomical grading of nerve sparing technique. [2] He used the visual cues derived from observations of the fascial layers and the prostatic veins [3]. The amount of peri-prostatic tissue preservation was based on risk stratification with the pre-operatively available cancer information including the findings of the MRI scan. The grading was from Grade 1 (complete Hammock preservation) to incrementally leaving less and less tissue to Grade 4, which is non-nerve sparing RALP. They found significant association between their incremental nerve sparing technique to return of erectile function and continence [4]. In contrast, Dr Vip Patel from Florida, have described a landmark artery known as the "prostatic artery" as a visual cue to determine the grades of nerve sparing technique [5]. Having performed the highest number of RALPs in the world, Dr Patel has shown that this landmark artery is present in 73.3% of their cases. Preservation of tissue medial to this artery were graded as complete and near complete NS techniques. Dissection lateral to the landmark artery

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results in varying degrees of incomplete NS. Grade 5 was regarded as complete NS (>95% of the tissue), Grade 4 (<75%), Grade 3 (50%), Grade 2 (<50%) and Grade 1 being Non-NS technique [6,7].

Suprapubic catheter placement and patient comfort

After RALP, traditionally a per-urethral catheter is inserted to act as a splint across the vesico-urethral anastomosis, in addition to draining the bladder. However, in young men, an indwelling catheter through the penis can cause discomfort and hence an approach by Dr Mani Menon to insert a suprapubic catheter [8]. Recently, they updated their experience on 339 patients who had a minimum of 1-year follow-up. Out of the 339 patients, one patient had a bladder neck contracture. In all, 16 patients (4.7%) required Foley placement for gross haematuria (two patients), urinary retention (three), tube malfunction (four) or need for prolonged Foley catheterization (seven). They concluded that after RARP, suprapubic catheter placement is safe and efficacious on long-term follow-up. They proved that splinting of the urethrovesical anastomosis is not a critical step of RP if a watertight anastomosis and excellent mucosal apposition are achieved [9]. The video of their technique of SPC insertion can be found in this reference [10]. Other leaders in the field of RALP such as Dr A. Tiwari have also adopted the SPC instead of a per-urethral catheter [11].

Nerve sparing improves continence

All these years, bilateral neurovascular preservation was considered important only for erectile function. However, several recent studies have shown a direct impact of nerve sparing RALP and continence preservation. Analysis of continence of nearly 1300 patients operated by a single surgeon (Dr Vip Patel) revealed that on multivariable Cox regression analysis that age ($p < 0.001$, hazard ratio 0.98, 95% CI 0.97-0.99) and nerve sparing were independent predictors. After adjusting for age, the hazard ratio was 1.61 (95% CI 1.25-2.07, $p < 0.001$) for partial nerve sparing and 1.44 (1.13-1.83, $p = 0.003$) for bilateral nerve sparing compared to the non-nerve sparing group. Return of continence was delayed in the non-nerve sparing group compared to nerve sparing counterparts. They concluded that the likelihood of postoperative urinary control was significantly higher in younger patients and when a nerve sparing procedure was performed [12]. Similarly, Dr Tewari reported his continence outcomes in 1546 patients undergoing risk-stratified grade of nerve-sparing technique of RALP. They concluded that there is a correlation between risk-stratified grade of NS technique and early return of urinary continence as patients with a lower grade (higher degree) of NS achieved an early return of urinary continence without compromising oncologic safety [4].

Barbed suture knotless urethro-vesical anastomosis

One of the most crucial steps in RALP is the urethro-vesical anastomosis (UVA). Not only this determines good continence post-operatively, but also prevents urine leakage to take place giving rise to post-operative urinoma and its sequelae. Traditionally, the UVA was carried out using a monofilament suture. The disadvantage of these sutures is the recoil that would take place after placement of each suture and constant need to check and tighten the anastomosis. Recently, there have been two kinds of barbed sutures, V-Loc™ (Covidien, Mansfield, MA, USA) and Quill™ (Angiotech Pharmaceuticals, Inc., Vancouver, BC, Canada). The first report of in-vitro use of a barbed suture for UVA was way back in 2007 [13]. However, it was in 2010 that Dr Mani Menon's group from Detroit first reported clinical experience with a novel technique of performing UVA during RARP. All their UVA

were performed without assistance and without tying a knot. Median time for entire dual-layer anastomosis was 14.0 minutes and that for UVA was 11 minutes. The major advantage was not having to rely on an assistant to follow the suture that decreased instrument clashes and entangling of the suture around an instrument. This translated into anastomosis being performed at a faster pace. Over the last 3 years, these barbed sutures have really demonstrated an advantage over the conventional monofilament sutures. In a randomized controlled trial comparing barbed and standard monofilament suture, Sammon et al demonstrated a 26% decrease in the anastomotic time with no increase in the adverse events, no instances of urinary retention and equivalent functional outcomes.[14] Professor Kevin Zorn from Canada looked at the time reduction and cost benefit in a prospective RCT of barbed polyglyconate suture to facilitate UVA during RALP. They found a significant reduction in mean nurse set-up time (31 vs. 294 s; $P < 0.01$) and reconstruction time (13.1 vs. 20.8 min; $P < 0.01$) in favour of barbed suture. They also showed that the need to readjust suture tension or to place additional suture clips for watertight closure was greater in the standard monofilament group than in the barbed suture group (6% vs. 24%; $P = 0.03$). A cost reduction was also noted with the barbed suture technique (48.05 vs. 70.25 \$CAN) [15].

Image guided surgery

The exciting future of robot-assisted surgery is going to be the integration of images that will help the console surgeon with identifying important landmarks. The ability MRI scan images to be over-laid onto the operating field will help the surgeon to understand key structures and navigate through the operation. This will become more and more important with increasing use of "incremental nerve sparing" techniques that are being developed. Dr Prokar Dasgupta and his group from London, recently reported wherein during surgery the surgeon can refer to the patient's magnetic resonance imaging overlaid on the endoscopic video image at the console. The result of the overlay process was measured qualitatively by the surgeon with reference to the desired clinical outcomes. They also reported that the use of the overlay system had not resulted in any measurable change in clinical outcomes. The surgeons found the system to be a useful tool for reference during surgery [16]. Another exciting development is the ability to use intra-operative fluorescence techniques during robotic procedures. The FireFly technique has become popular with robot assisted partial nephrectomy, but its utility is being investigated for sentinel lymph node (SLN) mapping in RALP. SLN staging biopsy using fluorescence-guided technique during Robotic Surgery is rapidly gaining popularity in endometrial carcinoma [17]. Similar proof of concept for prostate cancer surgery is being developed [18]. Imaging modalities like multiphoton microscopy, optical coherence tomography, Coherent anti-Raman spectroscopy, exogenous fluoroscopy using prostate-specific membrane antigen are being developed for better appreciation of the neurovascular bundle thus enabling better preservation of the NVB and avoiding positive surgical margin [19].

Conclusion

Advances in surgical techniques are resulting in better functional and oncological outcomes. This has a direct impact in improving the quality of life for the patients. Better understanding of the neurovascular bundles and the oncological safety can lead to less positive margins and better functional outcomes. More research into application of emerging technology such as integration of image-guided surgery will herald better outcomes in the near future.

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