# *Controlling the dorsal venous complex during robotic prostatectomy*

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TALUG C, JOSEPHSON DY, RUEL NH, LAU C, KAWACHI MH, WILSON TG. Controlling the dorsal venous complex during robotic prostatectomy. The Canadian Journal of Urology. 2012;19(1):6147-6154.

***Introduction:*** *The objective of our study was to determine whether dorsal venous complex (DVC) control technique influences positive apical margins following robotic assisted laparoscopic radical prostatectomy (RALRP).*

***Materials and methods:*** *One thousand fifty-eight patients who underwent RALRP at City of Hope from June 2007 to October 2009 were assessed. Endoscopic stapling and suture ligature of the DVC were compared. Positive apical margins were identified and compared based on DVC-control technique. Recurrence probability was estimated using the Kaplan-Meier method, and logistic regression analysis was used to predict the odds of positive apical margins.*

***Results:*** *Of 1058 patients, 633 (60%) underwent endoscopic stapling, and 425 (40%) had suture ligature. The groups had similar baseline characteristics including age and body mass index. We observed a statistically different PSA (5.4 ng/mL versus 5.2 ng/mL, p = 0.03) and operative time (2.8 hours versus 2.7 hours, p = 0.02) between stapling and suture groups, but the actual difference was small. Operative time, Gleason score, pathologic stage, and overall positive margin rates were not significantly different between groups. Positive apical margins were observed in 39 (6%) and 27 (6%) patients in the staple and suture groups, respectively. Multivariate analysis showed that the positive apical margin rate was greater in patients with higher pathologic stage and final pathological Gleason score.*

***Conclusions:*** *During RALRP, there is no difference in positive apical margin rate when the DVC is controlled using either endoscopic stapling or suture ligature. However, patients with a higher pathologic stage and final pathologic Gleason score are at higher risk for positive apical surgical margins.*

**Key Words:** RALRP, dorsal venous complex (DVC), positive margins, apical dissection, endoscopic stapling, suture ligature

## Introduction

With the widespread adoption of robotic technology, many urologic malignancies such as prostate cancer are increasingly being treated using robotic assistance. The advantages of robotic assisted laparoscopic radical prostatectomy (RALRP) include decreased blood loss, magnification of the operative field and improved visualization, decreased time to convalescence, and less pain medication requirements.[1] Modifications in the technique for RALRP have also evolved over time to improve the outcomes of cancer control, postoperative continence, and the return of erectile function. Similarly, those interested in RALRP are constantly evaluating modifications to improve the results of this less invasive surgical option.

Accepted for publication October 2011

Acknowledgments

The authors thank Nicola Solomon, PhD, for assistance in writing and editing the manuscript.

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In most reported RALRP series and in open radical retropubic prostatectomy, the apex is the most common site of a positive surgical margin (PSM).[2] Ahlering et al previously reported that the use of a vascular stapler on the dorsal venous complex (DVC) contributed to a decreased incidence of positive margins in patients with pathologic T2 disease,[3] suggesting that control of the DVC during surgery may influence the rate of positive apical margins.

At City of Hope, RALRP is the preferred technique for the surgical management of prostate cancer, and two different techniques are used to control the DVC; endoscopic stapling and suture ligature. The use of technique is based on surgeon preference. Theoretically, oncologic control of prostate cancer will increase with improved techniques in apical dissection. Therefore, we sought to determine whether DVC-control technique influenced the rate of positive apical margins during RALRP. Here, we report on a large series of patients who underwent RALRP over a 3 year period at City of Hope and compare the rate of positive apical margins between patients who had endoscopic stapling and patients who had suture ligature to control the DVC.

## Materials and methods

### *Patients*

In December 2000, a Prostate Cancer Database was established in the Department of Urology at City of Hope. The database collection system consists of Verity TeleForm scanable forms, image data capture and a Microsoft SQL Server database. All patients with prostate cancer who presented to our institution on or after January 1, 1995, and who received at least part of their treatment at City of Hope were evaluated for inclusion in this institutional review board (IRB)-approved database. Patient consent was obtained before enrollment into the database. Data on operative parameters and outcomes were then prospectively collected from the time of consent. For the current study we reviewed the database to identify factors related to PSMs at the apex, with operative reports reviewed to identify the technique used to control the DVC. We identified 1058 consecutive patients who underwent RALRP between June 2007 and October 2009; 633 had endoscopic stapling (Group 1) and 425 (Group 2) had suture ligature.

Preoperative factors including demographics, PSA, biopsy Gleason score, and clinical stage were compared between the two groups and the subsets of patients with positive apical margins in each group were identified. In addition, operative factors (including operative time and estimated blood loss) and pathologic factors (including final Gleason score and pathologic stage) were compared between the groups.

### *Surgeon experience*

All RALRP surgeries were performed with either endoscopic stapling or suture ligation between June 2007 and October 2009 by five different City of Hope surgeons. All surgeons were well-experienced robotic surgeons who were fellowship-trained in urologic oncology and/or robotic surgery. For inclusion in the study each surgeon was required to have performed at least 250 cases. Table 1 lists the individual experience

TABLE 1. **Surgeon experience**

| **Surgeon** | **Total RALRP† n = 2023** | **RALRP Endoscopic stapling Current study, n = 633** | **RALRP Suture ligature Current study, n = 425** |
|---|---|---|---|
| 1 | 908 (45%) | 0 (0%) | 425 (100%) |
| 2 | 807 (40%) | 398 (63%) | 0 (0%) |
| 3 | 296 (15%) | 68 (11%) | 0 (0%) |
| 4* | 12 (1%) | 76 (12%) | 0 (0%) |
| 5* | 0 (0%) | 91 (14%) | 0 (0%) |

†from June 2003 to May 2007 (prior to the span of this study), there were 2023 RALRP surgeries performed at City of Hope by the surgeons included in this study. The precise number of cases in which endoscopic stapling and suture ligature were performed (per surgeon) prior to inclusion in this study is not known.
*surgeon #5 joined the faculty of City of Hope in July 2007 and therefore does not have any historical case volume at the institution. Similarly, Surgeon #4 does not have a lengthy historical case volume at the institution. However, it should be noted that both surgeons are fellowship-trained in robotic surgery and have been involved in at least 250 RALRP operations.

of each surgeon included in the study, including the number of RALRP surgeries performed prior to the study for each surgeon while at City of Hope, the distribution of RALRP cases per surgeon in the current study, and the number of endoscopic stapling or suture ligation cases per surgeon for the current study. It is noteworthy that a single surgeon performed all of the RALRP cases in the suture ligature group; this surgeon has extensive experience in both approaches but favors suture ligature as the technique to control the DVC.

### *Surgical technique*

All prostatectomy procedures were performed transperitoneally with our institutional modifications to the Montsouris technique.[4] A 4-arm robot with two assistant ports for a total of six ports was used for RALRP. The fourth arm was placed through a port that was medial to the left anterior superior iliac spine. The procedure was initiated posteriorly to dissect out the seminal vesicles and vas deferens. The bladder was mobilized completely by bilaterally incising the peritoneum lateral to the medial umbilical ligaments. The medial umbilical ligaments and urachus were divided as cephalad as possible. The endopelvic fascia was left intact according to surgeon preference.[5]

Suture ligature was carried out using 0 vicryl on a CT-1 needle. Two passes were made from right-to-left to completely ligate the complex, which was then divided using sharp incision or monopolar cautery. In cases where the DVC was controlled with the endoscopic stapler, the Ethicon ETS45 stapler was used with a green, 45 mm cartridge. The stapler was positioned to compress and divide the complex to a level just anterior to the urethra to minimize the chance for staple migration into the urinary tract. The foley catheter was moved after placement of the stapler and prior to division of the DVC to ensure that the urethra had not been incorporated into the stapler.

The remainder of the apical dissection was carried out uniformly in all cases. The urethra was prepared just beyond the apex of the prostate, and the remainder of the antegrade neurovascular bundle preservation was completed in appropriately selected cases. The urethra was then sharply divided in a 270-degree fashion while leaving the urethra attached to the apex of the prostate at the 6-o'clock position. This allowed for placement of the initial anastomotic suture in the urethra prior to division of the remainder of the urethra.

### *Histopathological analysis*

Surgical specimens were fixed intact in 10% neutral buffered formalin. The outer surface was inked to delineate surgical margins (black) and the left (green) and right (blue) orientation. Prostate and seminal vesicles were sectioned transversely at approximately 5 mm intervals depending on specimen size. The pathologist identified the location and extent of cancer. The presence and location of extracapsular extension, seminal vesicle invasion, and Gleason score were recorded. A PSM was defined as tumor cells at the inked surface. Extracapsular extension was defined as tumor cells reaching the periprostatic adipose tissue with or without a positive surgical margin.

### *Statistical analysis*

Data analysis was performed using SAS software. Data were summarized using descriptive statistics, including the median and range for continuous data and proportions for categorical data. Univariate analysis to determine group differences were performed using the Pearson chi-square test or Fisher's exact test for categorical data, the Student t-test for normally distributed continuous data, and the Kruskal-Wallis test for non-normally distributed continuous data. Multivariate logistic regression was used to calculate odds ratios for predicting PSMs at the apex using age, body mass index (BMI), pre and postoperative Gleason score, prebiopsy PSA, pathologic stage, and surgical technique. Recurrence probabilities were estimated using the Kaplan-Meier method.[6]

## Results

### *Patient demographics and characteristics*

Table 2 lists the patient characteristics. There were 633 patients in Group 1 (endoscopic stapling) and 425 patients in Group 2 (suture ligature). There were no differences in age, race, BMI, or biopsy Gleason score between the two groups. There was a statistically significant but negligible difference in prebiopsy PSA values; Group 1, 5.4 ng/mL (0.1-99.7) versus Group 2, 5.2 ng/mL (range 0.4-36) ($p = 0.03$) and a slightly shorter PSA follow up time in Group 2. There were no statistically significant differences in patient demographics or characteristics between the patients with and without apical PSMs in each of the groups, Table 2.

### *Surgery and pathology*

Intraoperative and pathologic data are shown in Table 3. Median operative time was 2.8 (1.4-5.7) hours in Group 1 and 2.7 (1.7-5.2) hours in Group 2 ($p = 0.02$). The median blood loss (as estimated by the anesthesiologist) was 200 mL (50 mL-1700 mL) in Group 1 and 200 mL (25 mL-1300 mL) in Group 2 ($p < 0.0001$). There were no differences in pathologic stage or Gleason score at final pathology. There were also no differences in the overall PSMs between the two groups.

TABLE 2. **Patient characteristics**

| **Overall patient characteristics** | **Endoscopic stapling n = 633** | **Suture ligature n = 425** | **p value** |
|---|---|---|---|
| Age at surgery, median (range) | 63 (39.1-80.8) | 64 (43.3-84.7) | 0.36 |
| Race, n (%) | | | 0.34 |
| American Indian | 0 (0%) | 1 (0.2%) | |
| Asian | 35 (6%) | 23 (5%) | |
| Black | 25 (4%) | 21 (5%) | |
| Other/unknown | 14 (2%) | 4 (1%) | |
| White | 559 (88%) | 376 (89%) | |
| BMI, median (range) | 27.4 (18.9-46.3) | 27.2 (18.7-42.9) | 0.35 |
| PSA ng/mL, median (range) | 5.4 (0.1-99.7) | 5.2 (0.4-36.0) | 0.03 |
| Preoperative Gleason score, n (%) | | | 0.08 |
| ≤ 6 | 342 (54%) | 245 (58%) | |
| 7 | 227 (36%) | 149 (35%) | |
| 8-10 | 64 (10%) | 29 (7%) | |
| PSA follow up (mths), mean (range) | 13.3 (0-37) | 9.5 (0-38) | < 0.0001 |
| **Patients with apical PSMs** | **Endoscopic stapling n = 39** | **Suture ligature n = 27** | **p value** |
| Age at surgery, median (range) | 60 (39.1-74.6) | 64 (50.4-74.3) | 0.11 |
| Race, n (%) | | | 0.93 |
| Asian | 1 (3%) | 1 (4%) | |
| Black | 1 (3%) | 1 (4%) | |
| White | 37 (95%) | 25 (93%) | |
| BMI, median (range) | 27.9 (21.7-40.7) | 28.2 (22.8-36.5) | 0.43 |
| PSA (ng/mL), median (range) | 6.2 (2.0-99.7) | 5.3 (3.1-19.4) | 0.20 |
| Preoperative Gleason score, n (%) | | | 0.19 |
| ≤ 6 | 16 (41%) | 17 (63%) | |
| 7 | 14 (36%) | 7 (26%) | |
| 8-10 | 9 (23%) | 3 (11%) | |

PSM = positive apical margin

### *Positive surgical margins*

Positive surgical margins were defined as neoplastic prostate glands at the inked surface of the surgical specimen upon final pathologic examination. Apical PSMs were observed in a similar proportion of patients in both groups; 39 (6%) patients in Group 1 and 27 (6%) patients in Group 2 and there were no differences in apical PSMs between surgeons, Table 4.

A multivariate logistic model was then used to predict the odds of a PSM at the apex with the following dependent variables: age, BMI, pre and postoperative Gleason scores (≤ 6 versus > 6), PSA (≤ 5 verus > 5), pathologic stage (pT2 versus pT3/4), and DVC-control technique. The results of the multivariate model reveal that the incidence of an apical PSM is higher for patients with higher pathologic stage (OR = 2.72, p = 0.0008) and patients with a higher postoperative Gleason score (OR = 2.86, p = 0.0082). However, the effects of age, BMI, PSA, preoperative Gleason score, and DVC-control technique in the model were not statistically significant, Table 5.

## Discussion

The present study reveals a similar rate of apical PSMs regardless of whether endoscopic stapling or suture ligature is used to control the DVC. The factor that did influence the likelihood of apical PSMs was

TABLE 3. **Operative/pathologic data**

| **Operative/pathologic data** | **Endoscopic stapling n = 63** | | **Suture ligature n = 425** | | **p value** |
|---|---|---|---|---|---|
| Operative time, h, median (range) | 2.8 (1.4-5.7) | | 2.7 (1.7-5.2) | | 0.01 |
| Intraoperative blood loss, mL, median (range) | 200 (50-1700) | | 200 (25-1300) | | <0.0001 |
| Intraop transfusion, n (%) | 3 (1%) | | 3 (1%) | | 0.62 |
| Pathologic T stage, n (%) | | | | | 0.25 |
| pT2a/b | 80 (13%) | | 61 (14.4%) | | |
| pT2c | 433 (68%) | | 298 (70.1%) | | |
| pT3a/b | 120 (19%) | | 65 (15.3%) | | |
| Surgical Gleason score, n (%) | | | | | 0.71 |
| ≤ 6 | 192 (30%) | | 127 (29.9%) | | |
| 7 | 389 (62%) | | 270 (63.5%) | | |
| 8-10 | 42 (7%) | | 24 (5.6%) | | |
| Overall PSM, total n (%) | 122 (19%) | | 103 (24%) | | 0.06 |
| Surgeon 1 | - | | 103 (24%) | | |
| Surgeon 2 | 68 (17%) | | - | | |
| Surgeon 3 | 8 (12%) | | - | | |
| Surgeon 4 | 24 (32%) | | - | | |
| Surgeon 5 | 22 (24%) | | - | | |
| PSA recurrence, 24 mo., 95% CI | 9 (7-13) | | 8 (5-14) | | 0.0011 |
| | Overall | Any PSM | Overall | Any PSM | |
| Surgeon 1 | - | - | 8 (5-14) | 16 (7-32) | |
| Surgeon 2 | 7 (5-12) | 19 (9-35) | - | - | |
| Surgeon 3 | 13 (6-26) | 36 (11-84) | - | - | |
| Surgeon 4 | 9 (3-24) | 18 (4-60) | - | - | |
| Surgeon 5 | 16 (7-31) | 17 (4-55) | - | - | |

PSM = positive surgical margin; mo. = months; h = hours

disease stage; patients with more advanced disease as determined by pathological stage or Gleason score on final pathology had a significantly higher rate of apical PSMs.

Treatment for prostate cancer with radical prostatectomy is predicated on cancer control while minimizing both the peri and postoperative morbidity. It is estimated that less than 2 mm of tissue surrounds the margins of the prostate, and as a result, there is little room for error in surgical dissection.[7] One measure of a successful surgery is the margin status on pathologic analysis. With the higher frequency of PSMs at the apex of the prostate, modifications in surgical technique are necessary to minimize this pathologic occurrence.

It is widely believed that PSMs are an adverse pathologic feature that confers a poor prognosis. Several previous studies have documented that positive margins increase the rate of biochemical recurrence.[8-13] Prognostic implications based on the site of PSMs have been reported with varying results. Kordan and colleagues reported that the likelihood of biochemical recurrence for patients with a single apical PSM was less than in patients with a non-apical PSM or multiple PSMs. However, patients with a unifocal apical PSM had a higher recurrence rate when compared to those with negative surgical margins.[9] A review by Eastham et al analyzed PSMs classified by six different location and showed that PSMs located in the posterolateral area had the most significant impact on biochemical recurrence.[10] A study by Fesseha et al revealed that patients with an apical PSM had a similar recurrence rate to patients with organ-confined adenocarcinoma.[14] In contrast, the work of Salomon and colleagues documented a higher biochemical progression rate in patients with apical PSMs when compared with other PSM locations.[15]

TABLE 4. **Operative/pathologic data for patients with apical PSMs**

| Operative/pathologic | Endoscopic stapling n = 39 | Suture ligature n = 27 | p value |
|---|---|---|---|
| Operative time, h, median (range) | 2.8 (2.1-3.8) | 2.6 (1.9-4.0) | 0.21 |
| Intraoperative blood loss, mL, median (range) | 200 (75-500) | 150 (50-900) | 0.20 |
| Intraop transfusion, n (%) | 1 (3%) | 0 | 0.65 |
| Pathologic T stage, n (%) | | | 0.47 |
| pT2a/b | 0 (0%) | 1 (4%) | |
| pT2c | 25 (64%) | 16 (59%) | |
| pT3a/b | 14 (36%) | 10 (37%) | |
| Node positive, n (%) | 1 (3%) | 1 (4%) | 0.79 |
| Surgical Gleason score, n (%) | | | 0.10 |
| ≤ 6 | 3 (8%) | 6 (22%) | |
| 7 | 25 (64%) | 19 (70%) | |
| 8-10 | 10 (26%) | 2 (7%) | |
| Apical PSM, total n (%) | 39 (6%) | 27 (6%) | 0.89 |
| Surgeon 1 | - | 27 (6%) | |
| Surgeon 2 | 28 (7%) | - | |
| Surgeon 3 | 3 (4%) | - | |
| Surgeon 4 | 4 (5%) | - | |
| Surgeon 5 | 4 (4%) | - | |
| Apical PSM and PSA recurrence, 24 mo., 95% CI | 16 (6, 38) | 16 (4, 55) | 0.95 |

PSM = positive surgical margin; mo. = months; h = hours

TABLE 5. **Multivariate logistic regression predicting positive apical margins**

| Predictor | # non-missing | Odds ratio | 95% Wald CI | p value |
|---|---|---|---|---|
| Age at surgery (continuous) | 1056 | 0.97 | 0.94-1.01 | 0.10 |
| BMI (continuous) | 1034 | 1.02 | 0.96-1.09 | 0.50 |
| PSA<br>< 5 ng/mL<br>≥ 5ng/mL | 1050 | 1.05 | 0.61-1.79 | 0.87 |
| Preoperative Gleason score<br>≤ 6<br>> 6 | 1056 | 0.73 | 0.42-1.29 | 0.28 |
| Postoperative Gleason score<br>≤ 6<br>> 6 | 1044 | 2.86 | 1.31-6.25 | 0.0082 |
| Pathologic stage<br>pT2abc<br>pT3/pT4 | 1058 | 2.72 | 1.52-4.90 | 0.0008 |
| Surgical technique<br>Endoscopic stapling<br>Suture ligature | 1058 | 1.13 | 0.67-1.9 | 0.65 |

Other studies have demonstrated that the PSM site does not affect the likelihood of recurrence.[13,16] Boorjian and coworkers found that even though PSMs were associated with biochemical recurrence and the need for additional treatment, the cancer-specific and overall survival did not differ based on PSM location.[17] However, the implications of salvage therapy should not be underestimated. The morbidity associated with additional treatment can be profound and debilitating. In addition, data from CaPSURE reveals that PSMs have a high psychological impact on prostate cancer patients, with the fear of recurrence persisting even if adjuvant treatment is used.[18]

With the advent and widespread dissemination of robotic assistance in urology, techniques are constantly being modified to obtain an optimal result. After completing their first 50 RALRPs, Ahlering and colleagues altered their technique for dissection of the apex and control of the DVC to include endovascular stapling of the complex. They noted a decrease in the rate of PSMs from 36% in the first 50 patients to 17% in the next 90 cases.[3] Not only is it thought that endoscopic stapling reduces the rate of PSMs in pT2 patients, but proponents of this technique favor it because of its theoretical speed and consistency in controlling the DVC. However, it is possible that the improvement seen in the work of Ahlering and colleagues was reflective of increased surgical experience and progression along the learning curve rather than their alteration in surgical technique.

The present study reveals a similar rate of apical PSMs regardless of the technique used to control the DVC (6% in both groups) in the experience of surgeons who have all surpassed the learning curve associated with RALRP. While it is important to note the suture ligature group was operated on by a single surgeon and this may add inherent bias to the comparison of the two groups, the rate of apical PSMs was no different among the other surgeons, suggesting that both approaches are comparable with respect to the rate of apical PSMs.

At our institution, we do not have a uniform method for management of the DVC that is universally applied to all cases. We consider several factors including surgeon preference, patient anatomical characteristics and ease of applying the endovascular stapler versus the ability to reliably suture ligate the complex. In general, we believe that the endovascular stapler provides an efficient and reproducible method to secure the DVC. Although there was a statistically significant difference in operative time with shorter times observed in the suture ligature group in our series, this is not likely to be clinically significant and may be related to the fact that in some cases, a portion of the DVC needed to be oversewn after stapling to completely obtain hemostasis. In addition, even though EBL was lower in the suture ligature group, the difference in estimated blood loss between the groups is likely not clinically significant as there was no difference in transfusion rates.

As most urologic oncologists recognize, there are a number of variables involved with regards to achieving negative margins. We found a higher rate of overall PSMs in the suture ligature group despite a lower number of patients with extracapsular extension. Multiple variables outside the scope of the current study may be responsible for this; these include the number of patients undergoing bilateral nerve sparing, the number of patients undergoing inter versus intraversus extrafascial dissection, and modifications in operative technique. Regardless of the non-significant overall PSM difference between the groups, PSA recurrence rates at 2 years after surgery was similar between the two.

The present study has a number of limitations that deserve mention. First, it is a single institution evaluation. Second, the patients were not randomized to the two groups for management of the DVC, and the technique used was decided intraoperatively at the discretion of the surgeon. With the high volume of cases that have been completed at our institution and the experience of the surgeons in minimally invasive radical prostatectomy, it is possible that there are subtle intraoperative findings that are used as a guide to facilitate the apical dissection and determine the appropriate technique to control the DVC. Finally, as mentioned, while all surgeons were fully trained in both techniques, one surgeon performed all the suture ligature procedures compared to four surgeons who performed the endoscopic stapling. This may add inherent bias to the comparison of the two groups.

Radical prostatectomy is a technically challenging procedure. During open radical retropubic prostatectomy, apical dissection may be more difficult due to interference of the pubic arch or the difficulty in accessing the most distal portion of the prostate. However, during RALRP apical PSMs continue to be a concern. Smith and colleagues demonstrated that there was no difference in the rate of PSMs at the apex when comparing their robotic and open cohorts and 52% of PSMs in the robotic group occurred at the apex.[2] There are many implications of a PSM after prostatectomy, including patient and physician concern and the possible need for further therapy. In order to reduce PSM rates and their implications, it is imperative that modifications are made to improve outcomes.

## Conclusion

During RALRP, the rate of PSMs at the apex is not influenced by the type of DVC control used; endovascular stapling or suture ligature. Rather, apical PSMs occur more frequently in patients with a higher pathologic stage and Gleason score on final pathologic analysis. Since these characteristics cannot be determined with certainty preoperatively, continued refinements in surgical technique should be sought to minimize apical PSM rates. □

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