# Independent Predictors of Recovery of Continence 3 Months After Robot-Assisted Laparoscopic Radical Prostatectomy

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## Abstract

*Purpose:* To investigate the factors that predict recovery of continence within 3 months after robot-assisted radical prostatectomy (RARP).

*Patients and Methods:* The charts of 452 patients who underwent RARP with a minimum follow-up period of 3 months were collected prospectively and reviewed retrospectively. Urinary continence was determined using the self-administered validated Expanded Prostate Cancer Index Composite questionnaire during the routine follow-up visits.

*Results:* The overall continence rate 3 months after RARP was 79.9%. In an univariate logistic regression test, age < 70 years, higher preoperative Sexual Health Inventory for Men (SHIM) score, lower clinical $T_1$ stage, lower biopsy and pathologic Gleason score, shorter operative time, lower estimated blood loss, smaller prostate volume (< 40 cc) were associated with recovery of urinary continence within 3 months after RARP ($P < 0.05$). In multivariate logistic regression analysis, younger age, higher SHIM score, lower clinical $T_1$ stage, lower body mass index (BMI), and smaller prostate volume were independent factors that predicted return of continence within 3 months after RARP ($P < 0.05$).

*Conclusions:* Younger age (< 70 years), higher preoperative SHIM score, clinical $T_1$ stage, lower BMI, and smaller prostate volume (< 40 cc) independently predicted recovery of continence within 3 months after RARP.

## Introduction

**S**UCCESS OF RADICAL PROSTATECTOMY (RP) is often referred to as a trifecta: Oncologic control, continence, and potency. Among these three factors, urinary incontinence is generally perceived by the patients to be the greatest impairment in the immediate postoperative phase. To date, the published range of results concerning continence after RP has been wide. Notwithstanding, multiple major academic institutions have reported that the overall rate of continence defined as being pad-free after RP to be well above 90%.[1–5] Considering that there are patients who are destined to become incontinent after RP because of preoperative factors such as dysfunctional bladders and severe neurologic impairments, continence rates in the range of mid-90% are likely to be the best that can be reached by surgeons. Given these excellent long-term continence results, there is more interest in decreasing the time to full recovery of continence after RP.

To date, multiple factors that are associated with long-term continence have been reported. In contrast, there is a paucity of reports that examined early recovery of continence, especially in the context of the most commonly performed surgery for prostate cancer—robot-assisted radical prostatectomy (RARP). By identifying the preoperative factors that are associated with early return of continence, patients will be better informed concerning the potential outcomes of the surgery. Moreover, identifying patients who are at high risk for delayed return of continence may allow an earlier intervention such as biofeedback therapies that may enhance the likelihood of recovery of continence after the procedure.

At The Cancer Institute of New Jersey, more than 900 RARPs have been performed over the last 5 years by a single surgeon. In this study, we have investigated factors that predict early recovery of continence after RARP. Univariate and multivariate analysis were performed to identify factors

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that are independently associated with recovery of urinary continence within 3 month after surgery.

## Patients and Methods

### Patients

To date, more than 900 patients with clinically localized prostate cancer underwent RARP at The Cancer Institute of New Jersey (New Brunswick, NJ) by a single surgeon. After obtaining Institutional Review Board approval, a retrospective analysis of a prospectively maintained database revealed 452 patients with a minimum follow-up of 3 months who have completed the validated self-administered Expanded Prostate Cancer Index Composite (EPIC) preoperatively and postoperatively; preoperative and postoperative administration of EPIC at our institution was started in 2009. All patients, while waiting for the surgeon consultation, were given the questionnaire by medical technicians and collected by nurses. The surgeon was completely blinded to the results of the EPIC questionnaire.

In addition to the basic patient characteristics, prostate-specific antigen (PSA), Gleason score, clinical stage, Sexual Health Inventory for Men (SHIM), American Urological Association Symptom Score (AUA SS), and EPIC were recorded preoperatively. Evaluated operative parameters were operative time, estimated blood loss, and surgical complications. In this study, postoperative visits at 1 week, 1 month, and 3 months were reviewed. At each follow-up visit, patients completed the self-administered SHIM, AUASS, and EPIC questionnaires. Baseline characteristics of the patients in this study are shown in Table 1. Continence was defined as being pad-free (EPIC Question #5).

### Surgical technique

All procedures were performed using the da Vinci surgical robot system (Intuitive Surgical Inc., Sunnyvale, CA) via the transperitoneal approach as described previously.[6] In indicated patients, neurovascular bundles were spared athermally. The Foley catheter was routinely removed 7 days after surgery. Patients who had any additional technical modifications to improve continence (such as posterior urethral plate repair or Rocco stitch) were excluded from this study.

### Statistical analysis

Initially, all preoperative and operative clinical factors in our retrospective database underwent univariate analysis. Independent sample Student $t$ test, Fisher exact test, and chi-square test were used to evaluate the association of each factor with post-RARP incontinence at 3 months. Then the factors that the univariate analysis identified as being associated with early continence were subjected to multivariate logistic regression. Each candidate's prognostic factor underwent the Pearson correlation test to minimize statistical error from multicollinearity. After completing the first analysis only with the preoperative parameters, a second analysis was performed with all of the preoperative, operative, and pathologic parameters. Results were considered significant if the $P$ value was $\leq 0.05$.

## Results

Overall, the continence rate 3 months after RARP was 79.9% (361 of 452 patients). When preoperative factors were compared, age, preoperative SHIM score, and clinical stage were significantly different between the continent and incontinent groups ($P < 0.05$, Table 1). When intraoperative and pathologic factors were evaluated, longer operative time, higher estimated blood loss, and high Gleason score were associated with a lower rate of continence 3 months after RARP (Table 2). Perioperative complications were observed in only a very small number of patients in both groups (Table 3). To evaluate whether the learning curve affected the outcomes, we performed a subgroup analysis according to the order of operation. As demonstrated in Table 4, there was no difference in continence rate from the first to the last 100 cases analyzed in this study.

Table 5 shows the results of the univariate and multivariate regression test. The following eight parameters were associated with recovery of urinary continence 3 months

TABLE 1. PATIENT BASELINE CHARACTERISTICS AND PREOPERATIVE PARAMETERS

| | | Pad at 3 months (n=91) | No pad at 3 months (n=361) | Total (n=452) | P value |
|---|---|---|---|---|---|
| Age (years) | | 61.1±7.4 | 59.1±6.5 | 59.5±6.7 | 0.013[a] |
| BMI (kg/m$^2$) | | 29.1±4.6 | 28.2±4.3 | 28.4±4.4 | 0.097[a] |
| Race | White | 83 (91.2%) | 321 (88.9%) | 404 (89.4%) | 0.447[b] |
| | African-American | 6 (6.6%) | 30 (8.3%) | 36 (8.0%) | |
| | Asian | 2 (2.2%) | 10 (2.8%) | 12 (2.6%) | |
| Preoperative clinical stage | T$_1$ | 68 (74.7%) | 309 (82.8%) | 377 (81.2%) | 0.028[b] |
| | T$_2$ | 19 (20.9%) | 48 (16.1%) | 67 (17.0%) | |
| | T$_3$ | 4 (4.4%) | 4 (1.1%) | 8 (1.7%) | |
| Gleason score of biopsy | ≤7 | 65 (71.1%) | 281 (77.8%) | 345 (0.9%) | 0.178[b] |
| | ≥8 | 26 (28.9%) | 80 (22.2%) | 106 (13.5%) | |
| Preoperative PSA (ng/mL) | | 7.0±4.1 | 6.2±5.0 | 6.4±4.9 | 0.179[a] |
| AUASS | | 10.6±7.0 | 9.0±7.2 | 9.3±7.2 | 0.049[a] |
| SHIM | | 15.1±8.5 | 18.0±7.1 | 17.4±7.5 | 0.001[a] |

[a]Independent sample $t$ test; [b]chi-square test.

BMI = body mass index; PSA = prostate specific antigen; AUASS American Urological Association Symptom Score; SHIM = Sexual Health Inventory for Men.

TABLE 2. MULTIVARIATE ANALYSIS
OF FACTORS AFFECTING RECURRENCE

| Variables | Multivariate HR (95% CI) | p |
|---|---|---|
| T stage ($T_a$ vs $T_1$) | 0.571 (0.228–1.431) | 0.232 |
| Grade (high vs low) | 2.637 (1.182–5.882) | 0.018 |
| Tumor size (≥3 cm vs <3 cm) | 1.548 (0.668–3.588) | 0.308 |
| No. of tumors (multiple vs single) | 1.457 (0.593–3.580) | 0.412 |
| BCG (Yes vs No) | 0.550 (0.260–1.166) | 0.119 |
| Previous TUR (Yes vs No) | 1.434 (0.647–3.180) | 0.375 |
| Immediate 2nd TUR (Yes vs No) | 0.274 (0.112–0.669) | 0.004 |

HR = hazard ratio; CI = confidence interval; T = tumor; BCG = bacille Calmette-Guérin; TUR = transurethral resection.

after RARP in the univariate test: Age < 70 years, higher preoperative SHIM score, lower clinical T stage, shorter operative time, lower blood loss, smaller prostate volume (<40 cc), and lower biopsy and pathologic Gleason score. In the multivariate logistic regression analysis of the preoperative parameters, younger age, higher SHIM score, clinical $T_1$ stage, and lower body mass index (BMI) were independent factors that predicted early return of continence ($P < 0.05$). Postoperatively, smaller prostate volume (<40 cc) was an independent predictor of early recovery of continence ($P = 0.034$). The data summarized the impact of the three most important preoperative factors: Age, preoperative SHIM score, and clinical stage is shown in Table 6A; the significance of postoperative prostate weight is shown in Table 6B.

## Discussion

RP, regardless of surgical approach, leads to urinary incontinence that usually resolves by the end of the first postoperative year. In a study published in 2009, the continence rate after RARP was up to 97% at 1-year follow-up.[1–5] Likewise, the continence rate 1 year after RARP was 98% at our institution. Accordingly, as the rate of long-term continence is in the upper 90 percentile range in many high-volume academic centers, attention has been turned toward shortening the time to recovery of continence after RARP by identifying risk factors. In this regard, the present study demonstrated that younger age (<70 years), higher preoperative SHIM score, clinical $T_1$ stage, lower BMI, and smaller prostate volume (<40 cc) independently predicted recovery of continence within 3 months after RARP.

TABLE 3. SURGICAL COMPLICATIONS

| | Pad at 3 months (n = 91) | No pad at 3 months (n = 361) | Total (n = 452) | P value |
|---|---|---|---|---|
| Rectal injury | 0 (0%) | 4 (1.1%) | 4 (0.9%) | 0.313[a] |
| Ileus | 2 (2.2%) | 1 (0.3%) | 3 (0.7%) | 0.044[a] |
| Wound infection | 2 (2.2%) | 5 (1.4%) | 7 (1.5%) | 0.575[a] |
| Retention | 1 (1.1%) | 13 (3.6%) | 14 (3.1%) | 0.218[a] |

[a]Fisher exact test.

TABLE 4. LEARNING CURVE AND CONTINENCE
RATE AT POSTOPERATIVE 3 MONTHS
AFTER RADICAL PROSTATECTOMY

| Case group | Pad-free rate at 3 months | P value |
|---|---|---|
| 1 ∼ 100 | 72 (72.0%) | 0.644[a] |
| 101 ∼ 200 | 92 (92.0%) | |
| 201 ∼ 300 | 84 (84.0%) | |
| 301 ∼ 400 | 77 (77.0%) | |
| 401 ∼ 500 | 69 (69.0%) | |

[a]Chi-square test.

In an attempt to identify the factors that predict the recovery of continence long term, Shikanov and associates[7] reported that younger age, lower International Prostate Symptom Score and higher SHIM score were associated with continence 1 year after RARP. Similar analysis using the International Consultation on Incontinence Questionaire-Urinary Incontinence Short Form reported that patient age at surgery and Charlson comorbidity index were independent predictors of return to urinary continence.[8] In another study that assessed the functional outcome after both open and RARP, membranous urethral length and age were factors independently predictive of continence recovery.[1]

As for factors that predict recovery of continence within 3 months after RARP, there is a paucity of data. Lee and colleagues[9] reported that only age is associated with decreased odds of achieving continence at 6 weeks after adjusting for confounding factors in a multivariate logistic model. Unfortunately, this study's sample size of 107 was not sufficiently large enough to assess additional factors. More recently, a large RARP series revealed that age and nerve-sparing status were independent factors for the return of continence within 3 months after surgery.[10] Although this study included more than 1000 patients, multicollinearity was neglected and performed multivariable analysis of 21 parameters. As a result, only two aforementioned independent factors were identified.

To analyze independent risk factors for a specific outcome, multivariate logistic regression is commonly used. The most difficult part of this statistical method is deciding on which covariant to be included in analysis. If too many covariants are included, no factor can be statistically significant, because all of the risk factors are associated with each other to some degree. For example, if we set both BMI and weight as co-variant, both of them will not be significant because they adjust for each other. This technical difficulty, also called multicollinearity, accordingly has limited published studies to include no more than four to five factors in final multivariate analysis. On the other hand, if too few factors are included, the influence of other parameters is ignored and the significance of factors analyzed can be exaggerated. For example, in the context of incontinence, age has been considered the strongest factor in predicting the outcome. Because virtually all proposed preoperative risk factors correlate with age, however, the independent effect of age can be exaggerated if the number of factors analyzed is small. In short, the most important part of multivariate logistic regression analysis is to include risk factors that

TABLE 5. Univariate and Multivariate Analyses of the Variables Associated with Continence Recovery of 3 Months After Robot-Assisted Radical Prostatectomy

| | Univariate logistic regression | | | | Multivariate logistic regression of preoperative parameters | | | | Multivariate logistic regression of preoperative, operative and pathologic parameters | | | |
| | | 95% confidence interval | | | | 95% confidence interval | | | | 95% confidence interval | | |
| | Odds ratio | Lower | Upper | P value | Odds ratio | Lower | Upper | P value | Odds ratio | Lower | Upper | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age≥70 (years) | 0.207 | 0.088 | 0.486 | <0.001 | 0.277 | 0.109 | 0.704 | 0.007 | 0.281 | 0.109 | 0.729 | 0.009 |
| BMI (kg/m$^2$) | 0.959 | 0.913 | 1.008 | 0.102 | 0.950 | 0.902 | 1.000 | 0.048 | 0.947 | 0.899 | 0.998 | 0.040 |
| Clinical stage≥T$_2$ | 0.498 | 0.285 | 0.868 | 0.014 | 0.518 | 0.288 | 0.930 | 0.028 | 0.483 | 0.264 | 0.886 | 0.019 |
| AUASS | 0.970 | 0.941 | 1.000 | 0.051 | 0.995 | 0.962 | 1.028 | 0.747 | 0.998 | 0.964 | 1.032 | 0.894 |
| SHIM | 1.050 | 1.020 | 1.081 | 0.001 | 1.044 | 1.012 | 1.078 | 0.008 | 1.040 | 1.007 | 1.074 | 0.016 |
| Prostate size (cc) | 0.991 | 0.979 | 1.003 | 0.16 | - | - | - | - | - | - | - | - |
| Prostate size≥40 (cc) | 0.498 | 0.291 | 0.844 | 0.010 | - | - | - | - | 0.548 | 0.314 | 0.957 | 0.034 |
| Positive surgical margin | 1.069 | 0.544 | 2.103 | 0.846 | - | - | - | - | 1.077 | 0.523 | 2.214 | 0.841 |
| Bilateral NVB spared | 1.763 | 0.976 | 3.184 | 0.060 | - | - | - | - | - | - | - | - |
| Learning curve group (group of every 100 cases) | 0.922 | 0.775 | 1.097 | 0.359 | - | - | - | - | - | - | - | - |
| Operative time (min) | 0.993 | 0.989 | 0.998 | 0.003 | - | - | - | - | - | - | - | - |
| EBL | 0.999 | 0.997 | 1.000 | 0.033 | - | - | - | - | - | - | - | - |
| Preoperative PSA | 0.973 | 0.934 | 1.014 | 0.193 | - | - | - | - | - | - | - | - |
| Bx Gleason score | 0.774 | 0.637 | 0.941 | 0.01 | - | - | - | - | - | - | - | - |
| Pathologic stage≥T$_3$ | 0.408 | 0.156 | 1.067 | 0.068 | - | - | - | - | - | - | - | - |
| Pathologic stage | 1.032 | 0.825 | 1.29 | 0.783 | - | - | - | - | - | - | - | - |
| Pathologic Gleason score | 0.844 | 0.751 | 0.949 | 0.005 | - | - | - | - | - | - | - | - |

BMI=body mass index; AUASS=American Urological Association Symptom Score; SHIM=Sexual Health Inventory for Men; NVB=neurovascular bundle; EBL=estimated blood loss; PSA=prostate-specific antigen; Bx=biopsy.

Table 6. Predicted Table Demonstrating Incontinence Recovery at 3 Months After Robot-Assisted Radical Prostatectomy

A. Table applicable preoperatively

| | | Clinical stage $T_1$ | Clinical stage $\geq cT_2$ |
|---|---|---|---|
| Age ≤ 70 | SHIM > 16 | 86.5% | 77.8% |
| | SHIM ≤ 16 | 75.5% | 63.6% |
| Age > 70 | SHIM > 16 | 66.7% | 40.0% |
| | SHIM ≤ 16 | 61.5% | 33.3% |

B. Table applicable with pathologic data

| | | Prostate weight ≤ 40 g | Prostate weight > 40 g |
|---|---|---|---|
| Age ≤ 70 | SHIM > 16 | 92.9% | 80.3% |
| | SHIM ≤ 16 | 72.5% | 64.7% |
| Age > 70 | SHIM > 16 | 66.7% | 50.0% |
| | SHIM ≤ 16 | 61.5% | 46.1% |

SHIM = Sexual Health Inventory for Men.

have pathophysiologic and/or clinical rationale while excluding factors that have a small possibility of influencing the outcome.

In the current study, we used univariate analysis initially to determine the covariants for the multivariate logistic regression. This led to the inclusion of age, preoperative AUSSS and SHIM score, prostate size, clinical stage, bilateral nerve-sparing status, pathologic stage, BMI, and positive surgical margin. Importantly, all these variables have previously been reported to be an independent factor by multivariate analysis in eight recently published studies (Table 7).[1,2,7–12] Subsequently, multivariate logistic regression revealed that younger age (<70 years), higher preoperative SHIM score, clinical $T_1$ stage, lower BMI, and smaller prostate size (<40 cc) were independent factors that predicted return of continence 3 months after RARP. In contrast, preoperative AUASS, surgical margin status, pathologic stage, and nerve sparing were not associated with early recovery of incontinence.

Previously, two studies reported on the association between preoperative erectile function and post-RP incontinence. Shikanov and coworkers[7] reported that SHIM was independently associated with being pad free. From an article by Ko and associates,[10] patients who did not regain continence within 3 months had a significantly lower preoperative SHIM score than those who were continent. Although the precise reason for the connection between sexual function and continence is not known, it is well established that erectile dysfunction is a sensitive marker of peripheral microvascular damage.[13] Accordingly, the association between the higher preoperative SHIM score and increased rate of continence within 3 months after RP implies that healthy microvasculature may be necessary for healing of the urethrovesical anastomosis with minimal scarring.[3] Further studies are necessary to verify this concept.

It should be noted that there was a high degree of correlation among clinical stage, pathologic stage, and the status of nerve sparing (P < 0.001, in the Pearson correlation test). This observation likely reflects the fact that the clinical stage affects

Table 7. Eight Recently Published Studies Analyzing Postradical Prostatetomy Incontinence by Multivariate Analysis

| Authors | Year | Surgical approach | Time point of evaluation | Definition of continence | # of covariants | Age | Nerve sparing | Attempted nerve sparing | Prostate size | IIEF-5 ≥ 14 | SHIM | IPSS | BMI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kim[1] | 2011 | RARP and open RRP | 24 months | Pad free | 10 | (+) | (−) | | | | | | |
| Ko[10] | 2012 | RARP | 3 month | Pad free | 21 | (+) | (+) | | (−) | | (−) | (−) | (−) |
| Novara[8] | 2010 | RARP | 12 months | No leak | 2 | (+) | | | | | | | |
| Lee[9] | 2010 | RARP | 6 month | Pad free | 5 | (+) | (−) | | | | | (−) | (−) |
| Takenaka[11] | 2009 | LRP | 1, 3, 6 months | Pad free | 3 | (−) | | (+) at 6 months | | (+) at 3 month | | | |
| | | Open RRP | 1, 3, 6 months | Pad free | 3 | (−) | (−) | (−) | | (−) | | | |
| Shikanov[7] | 2010 | RARP | 1 year | Pad free | 4 | (+) | (−) | | | | (+) | (+) | |
| Konety[12] | 2007 | Open RRP | 6 months to 2 year | Pad free | 4 | (+) | | | (+) > 25 cc | | | | (+) |
| Burkhard[2] | 2006 | Open RRP | Until 2 years | Pad free | 7 | (+) | | (+) | | | | | |

(+) = included at multivariate analysis and statistically significant at multivariate analysis; (−) = included at multivariate analysis, but not statistically significant. IIEF-5 = International Index of Erectile function-5; SHIM = Sexual Inventory for Men; IPSS = International Prostate Symptom Score; BMI = body mass index; RARP = robot-assisted radical prostatectomy; RRP = retropubic radical prostatectomy; LRP = laparoscopic radical prostatectomy.

the surgeon's decision on approaching the neurovascular bundles. Because we were interested in identifying preoperative risk factors to better counsel the patients, clinical stage and not pathologic stage and nerve-sparing status were included in our final analysis to prevent multicollinearity. As for the operative time, there was a strong correlation with prostate size ($P < 0.001$ in the Pearson correlation test). Thus, in the final analysis, operative time was removed because of multicollinearity.

Three months after RARP, the overall rate of continence defined as being pad free in the present cohort was 79.9%. Factors that independently predicted the return of continence within 3 months after RARP were age younger than 70 years, higher preoperative SHIM score, lower BMI, clinical $T_1$ stage, and smaller prostate.

## Conclusions

Younger age (<70 years), higher SHIM score, lower BMI, clinical $T_1$ stage, and small prostate weight (<40 g) are independent factors that predict recovery of continence 3 months after RARP.

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## Disclosure Statement

Isaac Yi Kim is a consultant speaker for Amgen, and a consultant for Baxter. For the remaining authors, no competing financial interests exist.

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**Abbreviations Used**

AUASS = American Urologic Association Symptom Score
BMI = body mass index
EPIC = Expanded Prostate Cancer Index Composite
PSA = prostate-specific antigen
RARP = robot-assisted radical prostatectomy
RP = radical prostatectomy
SHIM = Sexual Health Inventory For Men