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Impact of a Multidisciplinary Continuous Quality Improvement Program on the Positive Surgical Margin Rate after Laparoscopic Radical Prostatectomy

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Abstract

Objective— Outcome after radical prostatectomy is highly sensitive to fine nuances in the surgical techniques. We sought to determine the impact of a process of continuous control and monitoring on the positive surgical margin rate in a contemporary series of laparoscopic radical prostatectomy.

Methods— Between January 2003 and October 2004, 301 men underwent laparoscopic radical prostatectomy for clinically localized prostate cancer (cT1–cT3a). A weekly case review conference involving surgeons, radiologists, and uropathologists was held to discuss the preoperative, intraoperative, and pathologic findings of significant cases. We analyzed the trend of positive surgical margins and compared the clinical and detailed pathologic characteristics of the cancer during the study period.

Results— We created logistic regression models with positive margin as the dependent variable and surgical experience as the predictor, adjusting for possible secular changes in disease severity (prostate-specific antigen, pathologic stage, and Gleason grade). There was a decrease in the rate of surgical margins: odds ratio 0.68/100 patients treated (95% confidence interval [CI] 0.44, 1.05; $p = 0.08$). The predicted probability for a positive surgical margin falls from 17.3% for the first patient to 7.5% for the 301st. These values are close to the observed rates for the first and last 50 patients. There was no important change in surgical risk over the course of the study, and the rate of nerve sparing remained stable throughout the study period.

Conclusions— In this contemporary series, which is unaffected by downward stage migration, the decreasing rate of positive surgical margins can be explained by subtle surgical technique modifications and a continuous multidepartmental effort for quality improvement.

Keywords

Prostatic neoplasms; Surgery; Laparoscopy; Pathology; Quality assurance; Health care

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1. Introduction

Positive surgical margin after radical prostatectomy is associated with higher rates of biochemical, local, and systemic progression [1–4]. Along with quality of life preservation, achieving negative surgical margins is one of the key outcomes measures after radical prostatectomy. In the last two decades, a significant trend toward a decrease in positive surgical margin rates has been demonstrated in large experiences of radical prostatectomy [5,6], and positive surgical margin rates as low as 5% for pT2 and 11% for pT3 patients are more frequently reported [7]. Many factors may have contributed to this trend, among them a tremendous stage shift in prostate cancer toward confinement of clinical disease [8–11], increased experience on the part of the surgeons, and advances in the surgical technique. Regarding the impact a surgeon may have on the pathologic results, it has been established that the surgeon is an independent predictor of outcome [12,13]. But the technique a surgeon uses is also a dynamic process, evolving with time, and many modifications have been proposed to improve postoperative outcomes [14,15].

For a recent technique, such as laparoscopic radical prostatectomy, regularly performed since 1998, these technical modifications along with the increased surgical experience are certainly the major factors that may have an impact on the positive surgical margin rate. In the reported initial experience of laparoscopic radical prostatectomy, positive surgical margin rates ranged from 19.2% to 26.3% and this represented a period during which the technique was being tested [16,17]. Now 7 yr beyond the developing phase, we sought to evaluate the rate of positive surgical margins in a contemporary series of 301 consecutive laparoscopic radical prostatectomies performed by one surgeon at the same institution and analyzed the effect of surgical technique modifications and continuous quality improvement efforts on the results.

2. Materials and methods

2.1. Patient population

Between January 2003 and October 2004, 308 consecutive patients underwent laparoscopic radical prostatectomy (LRP) performed by one surgeon at Memorial Sloan-Kettering Cancer Center. Seven patients who received neoadjuvant hormone therapy were excluded from this analysis, leaving a total of 301 patients as the population of this study. Preoperative prostate-specific antigen (PSA), biopsy Gleason score, and clinical stage according to the 2002 International Union Against Cancer TNM system were prospectively recorded in the prostate cancer database.

2.2. Surgical technique

The LRP performed was an evolution of the previously described Montsouris technique [18]. The first modification involved the apical dissection, with transection of the urethra at the end of the prostatectomy once the neurovascular bundles have been dissected off the apex and completely freed; the second modification is the intraoperative gross examination of the specimen before completion of the urethrovesical anastomosis, allowing frozen section examination of suspicious areas.

The extent of preservation of each neurovascular bundle (NVB) was planned by the surgeon preoperatively based on the results of the digital rectal examination, serum PSA, grade, location, and extent of cancer in each biopsy core as well as the results of endorectal coil magnetic resonance imaging. A final decision regarding the extent of NVB preservation that was to be performed was made depending on the intraoperative findings and eventually frozen section results, when required. The quality of the NVB preservation (preserved versus damaged versus resected) was recorded immediately postoperatively.

2.3. Pathologic examination

The surgical specimen was coated with India ink to delineate the surgical margins then fixed in 10% formalin. Prostate and seminal vesicles were step sectioned transversely at intervals of 3–4 mm. The prostate's most apical tissue (distal apex) was sectioned in the sagittal plane. Gleason score, pathologic stage, cancer maximum diameter, total tumor volume, number of cancer foci, and positive surgical margin status and site were prospectively recorded. The cancer characteristics were determined in total number of cancer foci per specimen, cancer maximum diameter in centimeters, total tumor volume in cubic centimeters, and surgical margins status (positive or negative).

A positive surgical margin was defined as presence of cancer at the inked margin of resection in the prostatectomy specimen, regardless of whether additional tissue was resected or not.

The incidence of indolent cancer was determined and assessed throughout this series; indolent cancer was defined as a cancer with a total tumor volume <0.5 cc, confined to the prostate (no focal or established extracapsular extension [ECE], and with no lymph nodes metastases) and no Gleason pattern 4 or 5 [19].

2.4. Quality improvement

The preoperative and intraoperative data of the cases with positive surgical margins were reviewed in a quality assurance conference involving genitourinary pathologists, radiologists, and surgeons. In parallel, correlation between the results of the whole mount sections of the surgical specimen and the intraoperative findings seen on the video was studied to help understand the mechanism by which a positive surgical margin occurs and to improve our intraoperative detection of the correct plane of dissection in a given patient [20].

2.5. Statistical analysis

Patients were ordered by date of surgery and assigned a value for prior surgical experience with n equal to the number of prior surgeries conducted; n therefore ranged from 0 to 300. Changes in clinical and pathologic characteristics in the study cohort over time were assessed by univariate regression. Our primary analysis was to determine how the rate of positive surgical margins changed with surgical experience. We created logistic regression models with positive margin as the dependent variable and surgical experience as the predictor. To adjust for possible secular changes in disease severity, we added PSA and prostatectomy Gleason grade and stage as covariates. In this model, Gleason grade was categorized as <7, 7, or >7; stage was dichotomized as 0 and 2 or 3 and 4. We also examined changes in nerve sparing with surgical experience. Nerve damage assessed by the surgeon as “probable” or “definite” on either side was classed as a failure to spare nerve. Analyses were conducted using Stata 8 (Stata, College Station, TX).

3. Results

3.1. Characteristics of the study population

Preoperative clinical parameters of the study cohort are shown in Table 1; Table 2 gives pathologic features and other postoperative data.

3.2. Changes in disease characteristics over time

No obvious changes occurred in the characteristics of the study cohort during the study. Except for the variables noted below, the p value for the association between disease characteristics and surgical experience was >0.15. There was some evidence of an increase in both the number of tumor foci (0.24 more foci per 100 patients treated; 95% confidence interval [CI], −0.01,

0.49; $p = 0.055$) and the volume of the prostatectomy specimen (1.99 cc increase per 100 patients treated; 95% CI, $-0.09, 4.06$; $p = 0.060$). There was a slight decrease in the incidence of indolent, organ-confined disease (odds ratio, 0.70/100 patients treated; 95% CI, 0.49, 0.99; $p = 0.046$), dropping from a rate of 20% in the first 100 patients treated to 10% in the last 100.

As a formal analysis for changes in disease characteristics over time, we created a logistic model for positive surgical margins using our prespecified primary covariates: PSA, pathologic stage, and Gleason grade. From this model, we derived a predicted probability of a positive surgical margin for each patient. In a linear regression, the change in predicted probability of a surgical margin, based on PSA, stage, and grade, was 0.005 (95% CI, $-0.008, 0.018$; $p = 0.4$) per 100 patients treated. In other words, there was no important secular change in risk factors for positive margins over the course of the study, and therefore any changes in margin rates are likely related to changes in surgical technique.

3.3. Analysis of positive surgical margins

There were 35 positive surgical margins in the cohort (11.6%; 95% CI, 8%, 15%). In univariate analysis, there was a decrease in the rate of surgical margins over time (odds ratio, 0.74/100 patients treated; 95% CI, 0.49, 1.12; $p = 0.15$). This odds ratio was slightly reduced after adjustment for PSA, stage, and grade (odds ratio, 0.68/100 patients treated; 95% CI 0.44, 1.05; $p = 0.080$). As a sensitivity analysis to guard against the possibility of overfitting, we used the predicted probability of a positive margin—obtained from the model with stage, grade, and PSA—as the covariate rather than the raw covariate values. The odds ratio was unchanged (0.66; 95% CI, 0.42, 1.03; $p = 0.064$). With increasing experience, the predicted probability for a positive surgical margin adjusted for PSA, pathologic stage, and grade, falls from 17.3% for the first patient to 7.5% for the 300th. These values are close to the empirical rates for both the first and last 100 patients (15% and 8%) and first and last 50 patients (16% and 8%).

Nerve sparing was successful in 219 patients (73%; 95% CI, 68%, 78%). The rate of nerve sparing remained stable throughout the study period (odds ratio for failed nerve sparing 1.02/100 patients; 95% CI, 0.76, 1.36; $p = 0.9$). Addition of nerve sparing to the multivariable model did not change the estimate for the association between surgical margins and surgical experience.

4. Discussion

A patient with clinically localized prostate cancer who is contemplating surgery must have a clear understanding of the treatment goal of radical prostatectomy: complete removal of the prostate, seminal vesicle, and lymph nodes (if indicated) with a negative margin and preservation of continence and potency. The operation is technically challenging and its outcomes are highly sensitive to the fine subtleties of surgical technique. Over the last 20 yr, significant progress has been made in both improving oncologic efficacy and reducing negative consequences on quality of life. Walsh's introduction of the anatomic radical prostatectomy dramatically improved the postoperative outcome, particularly erectile dysfunction, which before was an inevitable sequelae of this operation [15]; Eastham et al reported a significant impact of a modification in the surgical technique of apical dissection on the continence rate after radical retropubic prostatectomy [14]. Others have reported a decrease in positive surgical margins after specific alterations in the surgical technique [21].

Recently, centers with large radical prostatectomy experience reported a decreasing trend in the positive surgical margin rates over the years [5,6] and set the standard at 10% or lower. Three factors can explain this decreasing rate: changes in surgical technique, the increasing experience of the surgeon, and the downward stage migration of prostate cancer [12,21]. The latter remains a significant contributing factor; in a series of 9035 radical prostatectomies

performed between 1982 and 2001, Han et al reported an increase in clinical T1c from 10% to >70% and an increase in organ-confined disease from <40% during the period between 1982 and 1986 to >70% between 1997 and 2001. Derweesh et al reported data on 1505 men treated by either retropubic or perineal radical prostatectomy between 1987 and 2001; in their series the ECE rate decreased from 65.8% to 25.2% during the 15-yr study period. This downward stage shift was confirmed by others as well [5,8,10,11,22].

In the present study, in which the cohort is typical of the patient population at Memorial Sloan-Kettering Cancer Center, the downstaging is not a factor. The study population was treated within a short time frame, the clinical parameters are comparable, and, most importantly, the general pathologic data with detailed cancer characteristics, such as total tumor volume, cancer maximum diameter, number of cancer foci per specimen, and number of indolent cancers, were similar throughout this series. This leaves the surgeon and therefore the surgical technique as the sole variable influencing the decreasing trend in positive surgical margin rate.

It is our belief that the cause of this improvement is multifactorial and it is impossible to weigh the importance of each factor. With regard to surgical technique, the division of the urethra last allowed a better apical dissection of the neurovascular bundles by following the contours of the gland and isolating the urethra as the last prostatic attachment, allowing a better choice of site of urethral division. Second, the intraoperative macroscopic examination of the specimen when the prostate is freed, and before the initiation of the urethrovesical anastomosis, provides the surgeon with a learning feedback by correlating the frozen section results to macroscopically suspicious areas, if any. It is our belief that these helps train the surgeon in recognizing a dissection taken too close to the prostate. Finally, we find of benefit the continuous quality assurance and improvement program, by which pathologic and intraoperative documentation of positive surgical margins are reviewed with the purpose of understanding the factors leading to a surgical margin. This leads to a focus on improving surgical results, particularly in an environment where the standard set by the open radical prostatectomists is high [20].

In general, the positive surgical margin rates reported in the radical prostatectomy literature reflect a wide variability in range, 11–35% after open [23,24] and 19.2–26.3% after a laparoscopic approach [16,17,25]. If the positive margin variability of the mature open approach can be explained by differences in technique among different surgeons, those of the laparoscopic approach reflected at first the immaturity of the surgical technique and are merely the initial results of the pioneer teams who took up the challenge of developing a new technique. The present experience of laparoscopic radical prostatectomy shows that the procedure and, therefore, the results will continue to evolve beyond the “learning curves” a concept yet difficult to grasp, and often measured by a number of different generic end points such as the execution of basic laparoscopic skills, surgical morbidity, operating time, or intraoperative blood loss [26–28], and not by end points specific to radical prostatectomy such as positive surgical margin rate, erectile function, and continence.

It appears that “learning curve” associated with a certain number of cases is not appropriate to validate an experience, but contrarily that permanent quality assessment with constant auto-evaluation and constant comparison with other peers is the best way for continuous improvement. The concept of continuous quality improvement has been found to work effectively not only in manufacturing industries but also in human service industries including health care. In an era of evidence-based medicine, the application of this principle of monitoring, controlling, and improving performance can only be beneficial.

5. Conclusions

This contemporary experience suggests that, independent from the impact of stage migration, a decline in positive surgical margins through an institutional multidepartmental process of continued evaluation of surgical technique and outcomes is possible and needed to improve further the results of radical prostatectomy.

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Table 1

Preoperative clinical parameters

Age (yr)	<i>n</i> = 301: 59 (54, 64)
Prostate-specific antigen (ng/ml)	<i>n</i> = 301: 5.4 (4.1, 7.7)
Prostate volume (cc)	<i>n</i> = 283: 33 (24.6, 45)
Biopsy Gleason	
<7	194 (64%)
7	96 (32%)
>7	11 (4%)
Clinical stage	
T1b	1 (0%)
T1c	218 (72%)
T2a	47 (16%)
T2b	22 (7%)
T2c	9 (3%)
T3a	4 (1%)

Data are number (%) or median and interquartile range.

Table 2

Postoperative pathologic parameters

Prostatectomy Gleason	
<7	155 (51%)
7	134 (45%)
>7	12 (4%)
Pathologic stage	
pT0	1 (0%)
pT2a	32 (11%)
pT2c	192 (64%)
pT3a	60 (20%)
pT3b	11 (4%)
pT4	5 (2%)
Seminal vesicle invasion	12 (4%)
Specimen volume (cc)	<i>n</i> = 301: 40.6 (33.8, 50.9)
Tumor characteristics	
Total tumor volume (cc)	<i>n</i> = 299: 0.96 (0.36, 2.05)
Cancer maximum diameter (cm)	<i>n</i> = 299: 1.66 (1.16, 2.19)
Number of cancer foci	<i>n</i> = 299: 3 (2, 4)

Data are number (%) or median and interquartile range.