Radical prostatectomy stabilizes peak urinary flow rates

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Objective: *A community-based study of 2119 men in Olmsted County reported that median peak urinary flow rates (PFR)s and voided volumes decrease steadily after age 40. We wanted to study how removal of the prostate via radical prostatectomy (RRP) would effect age-related reduction of PFRs and voided volumes.*

Methods: *One hundred men 1-9 years following RRP were evaluated for PFR, voided volume, post void residual, and AUA symptom score.*

Results: *Following removal of the prostate the mean PFR was 26.6 +/- 11 cc/sec and the mean voided volume was 345 +/- 174 cc. Analysis of PFR and voided volume versus age were stable over all ages. PFR and voided volume versus follow-up demonstrated a flat or slightly positive slope. PFRs post RRP were higher compared to the community-based data that reported mean PFRs that dropped steadily for men in their 50's, 60's and 70's (25.8 to 18.6 cc/sec, 26.3 to 16.1 cc/sec, 27.3 to 13.8 cc/sec, respectively p≤ .01).*

Conclusion: *Following RRP, PFRs are, as expected, higher than historic controls and stable with advancing age and follow-up. This is in contrast to diminishing PFRs seen in normal men as they age. Our study suggests that age-related reduction in PFR and voided volumes is largely eliminated after total removal of the prostate gland.*

Key Words: radical prostatectomy, peak urinary flow rates, uroflowmetry

Introduction

The natural history of prostatic obstruction appears to predispose men to progressive lower urinary tract symptoms as they age. Most men over age 50 experience diminution of their urinary stream and some develop obstructive urinary symptoms. In 1993 in Olmsted County, Girman and associates[1] performed a community-based study measuring peak urinary flow rates (PFR) and voided volumes in 2119 men 40-79 years old with no history of prostate surgery, prostate cancer or certain other diseases known to interfere with normal voiding. They demonstrated an "aging" process manifest by declining voided volumes and a steady reduction in PFR of approximately 2 cc per decade of life starting

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at age 40. Roberts and associates[2] validated this by longitudinally assessing a subgroup of 492 men. Other studies have confirmed that PFR diminishes with age.[3,4]

Kuo studied flow rates and voided volumes of men following relief of prostatic obstruction via transurethral prostatectomy.[5] He demonstrated that men after successful TURP, similar to normal men, experience a steady decline in PFR and voided volumes as they age. Several authors have documented patient-reported urinary changes following radical prostatectomy.[6-9] Kleinhaus and associates measured PFR pre and post radical prostatectomy and demonstrated significant improvement within 6 months of surgery. However, they did not study how variables such as age and follow-up would effect PFR and voided volumes. We hypothesized that following total removal of the prostate, peak flow rates might stabilize and not naturally decline as seen in normal men or men post transurethral prostatectomy. To our knowledge, this is the first time this hypothesis has been studied.

Materials and methods

At routine postoperative follow-up, we invited men after previous radical retropubic prostatectomy to participate in the study. Human Subjects committee approval (HS # 98-84) and individual consents were obtained. We evaluated AUA symptom scores, uroflowmetry and post-void residual urine volumes. All prostatectomies were retropubic, performed in ascending fashion with bladder neck preservation and nerve sparing when appropriate. Exclusion criteria included a history of bladder cancer or previous bladder or urethral surgery, diabetic peripheral neuropathy, clinically confirmed bladder neck or urethral stricture disease, neurologic diseases known to effect detrusor function or patient refusal to participate. Patients, returning for follow-up visits, were selected randomly by a non-clinical member of the team (DS) to report with a full bladder for standard electronic uroflow testing (Dantec 1000), followed by post-void residual (PVR) measured via transabdominal ultrasound. Patients were instructed not to strain. They also completed a general health questionnaire and AUA symptom score. Men were asked to retest if voided volumes were less than 150 mls, and the test with the highest volume was used. PFR was defined as the highest flow rate during voiding lasting at least 1.5 seconds. The uroflow graphs were manually evaluated for signs of straining. No discrepancies were noted and the computerized values were used for the study.

Statistical analyses

Peak flow rates versus age and follow-up time, and voided volumes versus age and follow-up time were plotted on a scatter-graph and linear regression was performed to determine if a significant correlation between continuous variables existed.

Historical controls

For controls we utilized results from the Olmsted County community-based study published by Girman and associates[1] in 1993. In that study, 2119 men in Olmsted County who had no history of prostate or

TABLE 1. **Comparison of patient data of all 100 subjects to the subset that voided less than the recommended volume of 150 cc. Means are presented with standard deviations and ranges**

	All RRP	**Range**	**RRP < 150 cc**	**Range**
N	100		9	
Age	63.7 ± *7.2*	46 - 82	61.2 ± 8.9	48 - 73
Years postoperative	2.8 ± *2.2*	0.2 – 8.25	2.4 ± 2.4	0.2 - 6.8
Post void residual (cc)	28.1 ± *40.7*	0 - 221	27 ± 46	0 - 116
AUAss	6.6 ± *5.5*	0 - 33	8.4 ± 7.0	1 - 24
Uroflow				
Peak flow (cc/sec)	26.6 ± 11.7	6 - 54	19.9 ± 10.9	9.3 - 44
Voided volume (cc)	345.0 ± 174	98 - 812	116.2 ±12.6	97.6 - 140.6
Average flow (cc/sec)	10.2 ± 6.3	1.7 - 41	5.2 ± 1.7	1.7 - 7.4
Voiding time (sec)	43.6 ± 24.4	12 - 133	31.2 ± 15.2	20.6 - 68
Flow time (sec)	38.4 ± 18.8	12 - 96	26.6 ± 15.3	17.2 - 63.8
Time to peak flow (sec)	13.2 ± 10.7	0.8 - 55.4	13.8 ± 4.9	2.4 - 35

bladder cancer or surgery, and no history of neurologic diseases known to affect voiding function, were evaluated with in an attempt to establish urinary voiding standards in normal healthy men. These men were divided into age cohorts based on 5-year increments. Therefore, we used the higher PFR means and variance of the two 5- year cohorts for each age decade examined and sample size, to compute an approximate T-test (using the assumption of unequal variances) comparing the mean PFRs of our 100 RRP men to the 1993 published data.[1] Overall means between the two groups were tested as well as the means between each age cohort. Statistical calculations were performed using SAS statistical software.[10]

Results

One hundred men (mean age 63.7 years, range 46-82) agreed to participate in the study. Table 1 presents

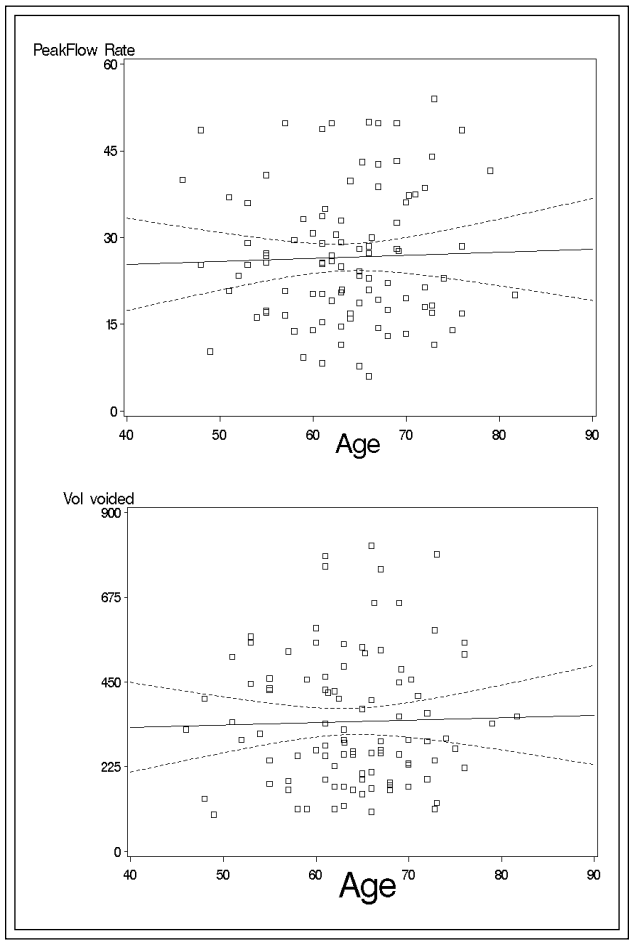

Figure 1. Linear regression of A. Age to peak flow rates and B. Age to volume voided of 100 radical prostatectomy patients. Confidence intervals (95%) of the slope range.

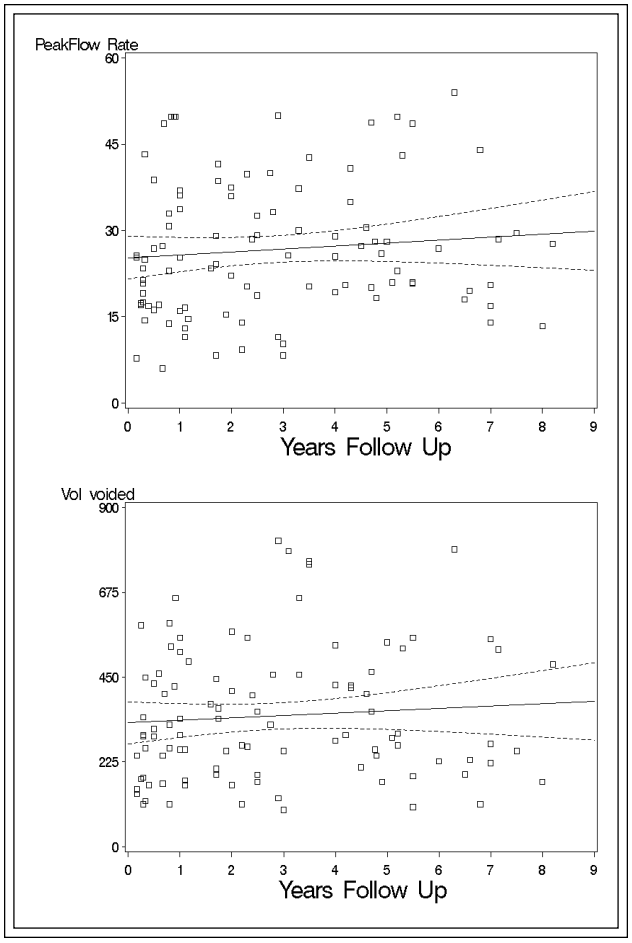

Figure 2. Linear regression of A peak flow rate to years follow up and B voided volumes to years follow up of 100 radical prostatectomy patients. Confidence intervals (95%) of the slope.

patient demographics and urinary test results. Nine patients voided volumes less than 150 cc and are presented for comparison. These nine patients are included in all of the following figures. Figures 1a and 1b depict the data of peak flow rate versus age and voided volume versus age. There is no discernable decrease in peak flow rates and voided volumes, in fact, a slight positive correlation may exist. Next we evaluated how PFRs and voided volumes changed with time following surgery. Figures 2a and 2b depict scatter-plots for PFR and voided volume with time and demonstrate a flat (or slightly positive) slope.

Comparison to historical controls

Figure 3 compares the mean peak flow rates of the post prostatectomy patients to historical age-matched normal control values. When segregated by decade, the mean

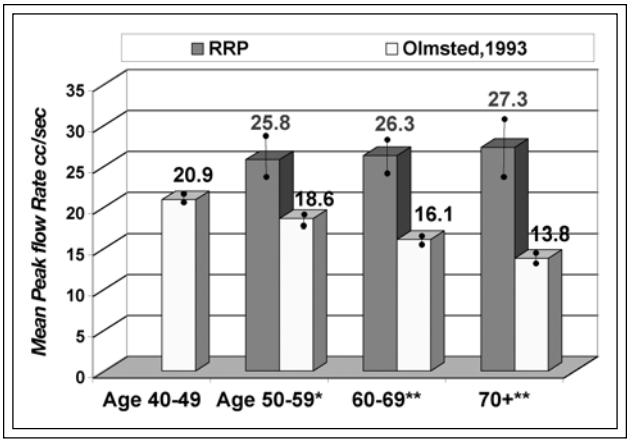

Figure 3. Comparison of peak uroflow rates for radical prostatectomy men versus Olmsted county historical control. The means vary significantly for age cohorts 50-59 (p*< .01) 60-69, 70+ (p**<.001) and total groups (p<.001). Standard error bars are shown.

PFR for post prostatectomy men in their 50's, 60's and 70's were 25.8, 26.3 and 27.3 cc/sec respectively. Men less than 50 years of age were excluded as a separate age group because there were only four patients (mean PFR = 31.1 cc/sec. Mean PFRs for radical prostatectomy patients were compared to controls from the Olmsted County study Figure 3. These differed significantly using the approximate t-test under the assumption of unequal variances for the total means.

Discussion

Girman and associates[1] and others have documented a steady decline in the PFR and voided volumes with age in men free of known urinary symptoms. Kuo[5] has also shown similar trends in PFR and voided volumes in men after a successful transurethral prostatectomy. In Kuo's study, men with a history of urinary obstruction were evaluated with uroflowmetry 6 months after a complication-free TURP. They noted that peak flow rates and voided volumes following TURP declined with increasing age of the men. So even though PFR and voided volumes are significantly improved following TURP, older men have lower average peak flow rates and voided volumes than younger men. Men who have had a radical prostatectomy free of urinary related complications present an intriguing system to study age related changes in peak urinary flow rates and voided volumes. The question we wanted to study is how total removal of the prostate would affect age-related changes of peak urinary flow rates and voided volumes.

It is well established that peak flow rates and voided volumes increase significantly following radical prostatectomy. Kleinhaus and associates[9] demonstrated using urodynamic testing that RRP significantly increases the PFR as compared to preoperative levels. In their study of 44 men, the mean preoperative to 6 month postoperative PFR increased from 18.4 to 29.3 cc/sec. However, they did not report any relationship with age to changes with either the PFR or voided volumes. In the present study, we evaluated the effect of age on PFR and voided volumes as seen in Figure 1. We also compared mean peak flow rates of post RRP men to asymptomatic age-matched historic controls in their 50's, 60's and 70's Figure 3. As demonstrated, when men undergo total prostatectomy, mean peak flow rates and voided volumes stabilize at approximately the same level regardless of age. Intuitively, we did not expect men above 65 years of age to have PFRs and voided volumes after radical prostatectomy equal to younger men in their fifties. This suggests that on average the age-related decline in PFR and voided volumes is a reversible process with total prostatectomy. For practical purposes, post RRP men might be expected to have similar age-related urinary flow changes as women. Drach,[11] Haylen,[4] and Fantl[12] have shown that asymptomatic women demonstrate no significant decline of peak flow rates with age. Relief of symptomatic obstruction via TURP, in contrast to total prostatectomy, does not alter age-related bladder dynamics in a similar fashion.[5]

Figure 2 depicts changes in peak flow rates and voided volumes with time following surgery. The scatter-plots demonstrate that PFR and voided volumes remain stable (or slightly increasing) out to 9 years following radical prostatectomy. The trend toward increasing voided volumes over time postoperatively may be due, in part, to gradual resolution of surgery-related stress urinary incontinence and increasing confidence of patients. The mean PFR was 26.6 cc and the mean voided volume was 345 cc which are similar to the results reported by Kleinhaus and associates.[9] Follow up extended out to 15 years and beyond will be necessary to confirm long-term results. Further, if long-term follow up does confirm these initial findings then during counseling for radical prostatectomy surgeons can explain that after successful surgery urinary parameters such as PFR and voided volumes should not diminish over time as one would expect for either observation or radiation therapy.

Uroflowmetry is a simple, noninvasive, and useful test to evaluate peak flow rates and voided volumes.

Uroflowmetry has important limitations when interpreting results. For example, patients with high-flow obstruction may be missed by uroflow alone. More invasive and expensive, pressure-flow studies are needed for such evaluations. There is some debate as to what constitutes an adequate voided volume, but many investigators agree that volumes greater than 150 ml are necessary for valid PFR measurements.[11] Our study evaluated urinary parameters for each patient at a single point in time, and similar to the Olmsted County study patients with voided volumes less than 150 cc were included. Our low volume voiders were also similar to that of the Olmsted County study, 9% versus 16%.

A weakness with our study was the absence of preoperative uroflowmetry, and while the Olmsted County database was large, it represents an historical control. The focus of the report was not to compare preoperative to postoperative levels. The focus was to characterize PFR and voided volumes following total prostatectomy with respect to age and follow up and hence we compared our results to historic controls for normal[1] and post TURP men.[5] Further, our mean peak urinary flow rates and voided volumes are similar to that reported by Kleinhaus and associates.

Conclusion

Our results demonstrate that complete removal of the prostate significantly alters the "aging" effect normally present in men. Peak flow rates and voided volumes following radical prostatectomy are stable with respect to patient age and remain stable with follow up. □

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