Changes in Uroflowmetry Maximum Flow Rates After Urethral Reconstructive Surgery as a Means to Predict for Stricture Recurrence

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Editor’s Note: This article is the fifth of 5 published in this issue for which category 1 CME credits can be earned. Instructions for obtaining credits are given with the questions on pages 2136 and 2137.

Purpose: A reliable, noninvasive screening method for urethral stricture recurrence after urethroplasty is needed. We hypothesized that changes in flow rates on uroflowmetry relative to preoperative values might help predict stricture recurrence.

Materials and Methods: All men who underwent urethral reconstructive surgery from 2000 to 2009 with adequate preoperative and postoperative uroflowmetry studies were included in the study. Preoperative and postoperative maximum flow rates were compared. The absolute change in maximum flow rate was compared between patients with and those without recurrence as determined by retrograde urethrogram.

Results: A total of 125 patients treated with urethroplasty were included in the study. Mean ± SD preoperative maximum flow rate was 11.8 ± 9.1 ml per second, which did not vary by stricture length (p = 0.11), patient age (p = 0.46) or stricture location (p = 0.58). The change in maximum flow rate in men without recurrence was 19.2 ± 11.7 vs 0.2 ± 6.4 ml per second (p < 0.001) in failed repairs. Setting a change in maximum flow rate of less than 10 ml per second as a screen for stricture recurrence would have resulted in a test sensitivity and specificity of 92% and 78%, respectively. There were 85 men without stricture recurrence who underwent more than 1 postoperative uroflowmetry study. Repeated maximum flow rate values achieved reasonable test reproducibility (r = 0.52), further supporting the use of uroflowmetry.

Conclusions: Change in flow rate after urethral reconstruction represents a promising metric to screen for stricture recurrence that is noninvasive and has a high sensitivity.

Key Words: urethral stricture, treatment outcome, urodynamics

UROFLOWMETRY is one of the most commonly performed procedures in urological clinics.1,2 The most common disease for which UF is used is BPH.3 UF provides objective data regarding patient voiding, and these values can be followed longitudinally, then monitored to measure the need for and the efficacy of interventions. UF has also become a common method to evaluate men with urethral stricture disease.4,5 In a recent systematic review article Meeks et al demonstrated that UF was the most common method of following the progression of stricture disease, as it was used in nearly 60% of the included citations.6 However, the use of UF in urethral stricture disease has not been adequately studied. Therefore, we evaluated UF changes in patients with urethral stricture who have undergone urethral recon-
UROFLOWMETRY FOR PREDICTION OF STRICTURE RECURRENCE

MATERIALS AND METHODS

Patient Selection
We analyzed our prospectively maintained, institutional review board approved urethroplasty database for men who had undergone urethral reconstructive surgery in the last 10 years. All men who underwent anterior urethroplasty who had preoperative and postoperative UF studies were initially included in the study. Only those men with complete and adequate UF studies, defined as those in which VV was 150 cc or greater, with the maximum flow rate measured and the generated voiding curve analyzed, were included in analysis.

Perioperative Management
Our routine preoperative protocol was for all patients referred for the treatment of urethral stricture disease to undergo UF before combined RUG/VCUG study. Previously described urethroplasty techniques were then performed in all patients. The operative catheter generally stayed in place for 3 weeks postoperatively, at which time VCUG was performed to evaluate for extravasation at the site of the repair. If extravasation was seen the catheter was replaced. Otherwise the next scheduled followup was at 3 months, when another UF study was performed with concomitant RUG/VCUG studies. If the repair looked adequate at 3 months the next scheduled followup was at 1 year, when another set of UF/RUG/VCUG studies was performed. After this time subsequent followup visits included only UF studies, unless the patient presented with voiding symptoms or UF studies were suggestive of obstruction, in which case repeat RUG/VCUG studies were performed.

Uroflowmetry
All UF studies were performed with the guidance of our trained nursing staff when patients first arrived at the clinic. We asked all of our patients to withhold from voiding before the visit so that the largest volume void was achieved, which helped with study accuracy. From the UF study we obtained a VV, a fmax and an average flow rate. In addition, a flow curve was generated from the void, that is a linear representation of the flow rate over time. The shape of the curve was interpreted by 1 physician (JWM), and was recorded as normal/bell-shaped or obstructed/flat. The VV, fmax and shape of voiding curve were recorded in our prospectively maintained database.

Data Analysis
Descriptive statistics were used to characterize the study population and ANOVA was used to assess differences among groups for continuous variables. For paired continuous data such as preoperative and postoperative fmax the paired t test was used. The nonparametric pair-wise correlation was determined in patients with multiple postoperative uroflow readings and no history or recurrence to assess uroflow variability. Statistical significance was set at p < 0.05 and all tests were 2-sided. Excel 11.6 and STATA® 11 were used for all analyses.

RESULTS
A total of 405 men underwent urethral reconstructive surgery during the study period. Of these men 125 (31%) had adequate preoperative and postoperative UF studies, and were included in the analysis. Patients were excluded because of no/inadequate preoperative UF study (186), no/inadequate postoperative UF study (44) or both (50). Mean age in this group was 43.7 ± 16.4 years, mean stricture length was 3.4 ± 2.9 cm and mean followup was 18.0 ± 22.9 months. Repair locations were bulbar (125), penile (45) or both (4). Repair types were anastomotic (60) and onlay with buccal mucosa (65). Excluded patients had demographic data similar to those of included patients except for longer stricture length (4.5 vs 2.2 cm, p < 0.001) and percentage of fasciocutaneous flap repairs (24.3% vs 0%, p < 0.001).

Average preoperative fmax was 11.8 ml per second (± 9.1). Preoperative fmax did not vary by stricture length (p = 0.11), patient age (p = 0.46) or stricture location (p = 0.58). Preoperative average VV was 319 ± 142.4 ml, which also did not vary by patient age (p = 0.15), stricture length (p = 0.73) or stricture location (p = 0.64). The preoperative voiding curve was obstructive in 119 (95.2%) men.

Postoperative fmax improved significantly (11.6 ± 0.88 vs 24.6 ± 1.3 ml per second, p < 0.001) with no significant differences in the magnitude of change seen among repair types (anastomotic −9.9 to 26.9 ml per second, p < 0.0001; onlay −12.9 to 20.7, p < 0.0001). VV also improved slightly (321.9 ± 13 vs 363.9 ± 16.3 ml, p = 0.019). The number of men with obstructive voiding patterns (flat curve) decreased significantly (92.5% vs 29.7%, p < 0.001).

There were 33 (26.4%) men with postoperative recurrence on routine RUG/VCUG studies (mean 13.0 ± 17.8 months) with acceptable preoperative and postoperative UF studies. Preoperative and postoperative fmax at the time of failure diagnosis were not significantly different for this group (9.4 ± 6.4 vs 10.6 ± 7.2 ml per second, p = 0.29). In addition, all men with recurrence had obstructive voiding patterns at the time of failure.

The postoperative Δfmax in men with successful and unsuccessful repair is shown in the figure. Mean Δfmax was 19.2 ± 11.7 ml per second for successful urethroplasties and only 0.2 ± 6.4 ml per second (p < 0.001) for unsuccessful urethroplasties. Using fmax Δ+ 10 ml per second as a screen for postoperative recurrence yielded a sensitivity of 92% and a specificity of 78% (see table). A total of 85 men without evidence of recurrence on RUG/VCUG under-
went more than 1 postoperative UF study. Comparison of the initial and second postoperative UF studies generated an R value of 0.52, indicating strong test reproducibility.

DISCUSSION
We studied the use of UF in the preoperative and postoperative evaluation of patients who underwent urethral reconstructive surgery, and showed that significant voiding improvements in voiding curve and maximum flow rate, on average around 19 ml per second, can be expected in most patients after successful urethroplasty. This improvement occurs regardless of preoperative stricture location or length, or type of surgical repair. In addition, we showed that in men with stricture recurrence, as demonstrated on RUG/VCUG studies, significant improvements were not seen, indicating that UF may be a useful, noninvasive way to distinguish between a successful and an unsuccessful repair.

UF is a ubiquitous test in urology clinics and is used for many cases of BPH. The test commonly gives 3 objective data points of fmax, average flow rate and VV. Most UF equipment will also generate a voiding curve, depicting flow rate over time. The data most often used are the fmax values. However, the ability of the fmax to diagnose true obstruction in men with BPH has been questioned, with multiple studies showing a test sensitivity and specificity to predict for obstruction in only 40% to 60% and 50% to 90%, respectively.10–12

We previously reported on the use of UF to diagnose recurrence after urethral reconstructive surgery and concluded that UF was not useful as a stand-alone tool to screen for postoperative stricture recurrence.4 Had a commonly cited cut point of 15 ml per second been used to screen for recurrence,13 it would have missed nearly half of the recurrences in the series, indicating that in a significant number of men the absolute fmax was not necessarily decreased in the setting of obstruction. Indeed, other less objective factors proved to be much more useful in predicting recurrence, including the shape of the voiding curve and the presence of voiding symptoms. However, we acknowledged that static UF data points are influenced by factors other than the degree of urethral obstruction, including inherent bladder contractility, patient age and the degree of obstruction from prostatic hypertrophy.

Because of the many confounding variables influencing fmax, we hypothesized that a more important variable to follow might be the Δfmax experienced by each individual patient after urethral reconstructive surgery. For example, an elderly patient with prostatic hypertrophy and urethral stricture may generate a fmax of only 13 ml per second after successful urethroplasty as confirmed on a VCUG/RUG study. When taken alone this number might be considered an obstructive flow rate. However, when the value is compared to the preoperative maximum flow rate of 2 ml per second, a Δfmax of 11 ml per second is generated, indicating a significant improvement in voiding and, likely, successful urethroplasty. On the other hand, a young patient with stricture disease with a normal, healthy bladder without BPH might present preoperatively with a fmax of 18 ml per second. After urethroplasty fmax might improve to 20 ml per second, which taken alone could indicate successful repair. However, with a Δfmax of only 2 ml per second, the integrity of the repair should be questioned.

In this study Δfmax was significantly different in patients with and in those without stricture recurrence. More importantly, setting an arbitrary cut point of Δ10 ml per second to screen for stricture
recurrence resulted in a sensitivity and specificity of 92% and 78%, respectively, compared to the gold standard RUG/VCUG studies. This is significantly better than what we had found in our previous study using static fmax values (cut point of 10 ml per second, sensitivity 54%), indicating that following the fmax longitudinally might be an appropriate, noninvasive way to screen for urethral recurrence. Additionally, with a test specificity of 78%, fewer unnecessary tests would be performed, thereby minimizing complications and costs.

Important limitations of the study must be discussed. There were more patients with recurrence (26.4%) included in the study than are found in a typical urethroplasty series, reflecting the fact that more patients with stricture recurrence will return for follow-up UF studies. This disproportionate study population tends to falsely increase the positive predictive value of UF when used as a screening tool. In addition, there was a high study exclusion rate, the most common reason being inadequate UF studies. Conducting appropriate UF studies in the clinic setting can be a challenging endeavor, often hampered by patients being unable to void, not voiding enough or not voiding in the appropriate locations. A concerted effort is required by the nursing staff and the patient to ensure a high percentage of adequate voids, and this cannot always be guaranteed, even in the most controlled settings. Because of these inherent limitations with UF, if a noninvasive protocol for monitoring the status of the urethra after urethroplasty is ever to be studied or used prospectively, alternate modalities including symptom analysis must also be included to ensure that there are other complementary ways to screen for recurrence.

CONCLUSIONS

UF can be a useful tool to monitor for stricture recurrence after urethral reconstructive surgery, especially if preoperative and longitudinal UF data are available. However, inherent problems with UF test administration in the clinic setting make it difficult to rely entirely on UF to diagnose recurrent urethral stricture disease if a completely noninvasive means of monitoring is desired.

REFERENCES