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The role of intra-operative void score during transurethral resection of prostate as a marker of efficacy: a feasibility study

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Abstract

Background: To assess the feasibility of a novel intra-operative void scoring technique. To determine if intra-operative void score (VS) could act as a marker for post-operative success following TURP.

Methods: Fifteen patients undergoing TURP were included in this single-centre feasibility study. All patients had indwelling urinary catheters for recurrent retention due to benign prostatic hyperplasia (BPH). In theatre, immediately before- and after TURP, an intra-operative VS was measured and graded 0–5. Primary outcomes were the feasibility of measuring intra-operative VS and its accuracy in predicting surgical outcome.

Results: A combined pre- and post-score with a threshold ≥6 correctly predicted 82% of those who were catheter free (sensitivity) and 100% of those who were not catheter free (specificity) at follow up and the positive predictive value was 100% and negative predictive value 60%.

Conclusion: Intra-operative void score during TURP is simple, reproducible, fast and requires minimal resources. In TURP it may predict successful outcomes by identifying patients who will be catheter free post-operatively as opposed to those who will be catheter dependent despite the procedure.

Introduction

Transurethral resection of the prostate (TURP) remains the gold standard intervention for bladder outlet obstruction (BOO).[1] Lower urinary tract symptoms in males significantly increase with age, especially after 60.[2] Reports from North America have suggested that acute urinary retention has been increasing and so too has the need for catheterisation.[3] TURP is likely to have an increasing role in the relief of symptoms and catheter dependence due to BPH in the future.[1]

The most relevant complications are unsuccessful trial removal of catheter (TROC) in 5.8% and requirement for surgical revision in 5.6%.[4] The management of these complications are associated with substantial costs, both in terms of health resources and finances.[5] How do we currently identify who will benefit most from TURP?

Recurrent UTIs, urinary retention requiring indwelling catheter, larger post void residual volumes, smaller prostate sizes, lower bladder capacity and compliance are all poor prognostic indicators.[6] Similarly, bladder characteristics on ultrasound have also been correlated with efficacy outcomes.[7]

A local anecdote describes a method of predicting post-operative flow outcomes after TURP. This may stem from Wardill's Test, originating in England.[8] It has been passed on by supervisors over generations and it holds the basis for what current Urologists remark as 'a good TURP'. Immediately after the prostate

resection (the bladder remaining full) the cystoscope is removed, and pressure applied to the suprapubic area to expel the bladder contents. The voided flow, if considered (subjectively) strong, suggests that an adequate resection had been performed and that the patient will have a successful outcome with a good post-TURP flow rate. In our institution, this method has colloquially been referred to as the 'Chambers Test', after Roger Chambers an Auckland Urologist. Unfortunately, no evidence exists to support the principles of this test. Does intra-operative urinary flow rate predict post-operative outcomes? Or is this anecdote mythological folklore.

The aims of our study were primarily to assess the on-table 'Chambers test' following TURP as a feasible method of allowing measurement of flow, and secondarily to determine if it could reliably predict post-operative catheter-free success.

Materials and methods

A consecutive series of patients with BPH and indwelling urinary catheters (IDUC) who required treatment with monopolar TURP, were prospectively enrolled in a single tertiary care centre between August 2018 and September 2019. An independent ethics committee approved the study and informed consent was obtained for all included patients. Clinical Trial ID: ACTRN12618001967279.

Patients were included if they had persistent urinary retention requiring IDUC despite optimal medical therapy for BPH. Exclusion criteria were urothelial malignancy, neurological disorders, and other bladder neck/urethral pathology.

Age, ethnicity, co-morbidities and ASA grade were collected retrospectively from medical records for all patients at baseline.

Intra-operative 'Chambers test' void score technique

A standard monopolar TURP was carried out on the patient by a single operator (Consultant Urologist) under spinal or general anaesthetic. There was no deviation from the standard surgical technique of the prostatic resection using a 26-Ch continuous irrigation resectoscope.

Prior to resection and immediately following resection, the Chambers test intra-operative void score (VS) assessment was performed as follows:

- Before TURP the bladder was emptied via rigid cystoscopy, 300 mL of glycine irrigation solution then instilled via the cystoscope.
- Cystoscope is removed and an average force of 50 Newtons applied to the suprapubic area of the abdomen by the single operators' hand. (This force was a 'learned' application prior to surgery where the single operator used a digital non-spring scale placed on an abdomen applying the above force, they were then blinded and applied the force to the scale 100 times, each time reproducibility was verified until the force was 'learned'. This was re-tested at completion of the recruitment and an average of 50 Newtons verified).
- Void score (VS) = The flow of the voided fluid subjectively is graded by 2 assessors (the same consultant Urologist and registrar for all cases) from zero to five on a pre-set scale (0 = no flow, 1 = dribble, 2 = poor, 3 = moderate, 4 = good, and 5 = excellent).
- This was carried out twice for reproducibility with a score of unanimous decision.
- The manoeuvre was repeated after prostate resection giving each patient a pre-resection- as well as a post-resection VS.
- The difference in VS was calculated as the Change in VS: post-resection score minus pre-resection score = change in VS.
- A combination VS was also calculated by: post-resection score + change score = Combined VS.
- After preliminary analysis, the combined VS was found to better discriminate between patients who had high scores both pre- and post-procedure and patients who had low scores both pre- and post-procedure. The addition of the change in VS enables a similar estimate of successful outcome for both of these patient groups.

Post-operative pathway and outcomes

The study's primary aim was to investigate the feasibility of measuring intra-operative Chambers Test as a surrogate for flow rate assessment. The secondary aim was to estimate its accuracy in predicting TROC outcomes. Feasibility was assessed in terms of the tests resource consumption, efficiency/time commitment, reproducibility, and the operators' subjective ease of performance. Two primary catheter outcomes were assessed: successful first trial removal of catheter (S1TROC), performed on day 1 after TURP providing that haematuria had settled, and catheter free by follow up (CFF)—typically 10–12 weeks after TURP. Post-operative recovery in the ward proceeded as per the standard institutional elective TURP pathway. In the ward, S1TROC was determined by medical/nursing staff blinded to Chambers test results. If the TROC was unsuccessful, the catheter was replaced, the patient discharged and repeat TROC arranged 2 weeks later.

Statistical analysis

Descriptive statistics were presented using mean and range for continuous variables and number and percent for categorical variables. Diagnostic test accuracy was estimated using sensitivity and specificity for the three measures (Post-operative score, Change score and a Combination score) for the two outcomes of interest (S1TROC and CFF). The receiver operating characteristic (ROC) curve for each of these three measures was plotted by varying the threshold for a positive test. The area under the ROC curve (AUC) then estimated. Based on the ROC curve the threshold giving sensitivity/specificity pairing closest to the top left-hand corner was found, that is, the threshold of optimum balance between sensitivity and specificity. For each of these thresholds the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were estimated. All analyses were done in Stata/SE 16.[9]

Results

Twenty-one consecutive patients with BPH and IDUC undergoing TURP over a 14-month period were recruited. Two were excluded for alternative pathology and TURP was not indicated. Four were excluded due to the unavailability of a second assessor, and therefore a breach of study protocol. Overall, 15 patients were included. Fourteen completed their outpatient follow up at 10 weeks. One patient died in the community (cause of death unrelated to TURP) prior to follow up. Baseline patient characteristics are summarized in Table 1.

The on-table Chambers test took about 2 min to complete before and after resection, predominantly due to bladder filling time. The technique proved to be simple and straightforward according to feedback from the operator, assessors and theatre staff. The first 300 mL was used from the standard glycine fluid bags for the operation, no extra equipment was necessary and the impact on resources therefore minimal. The learned technique applying abdominal pressure appeared reproducible with similar pressure before and after recruitment. VS remained unchanged after dual assessment. Assessors reported the pre-set VS scale as being clear-cut. In the case of the 15 patients specifically, the independent scores from each assessor were the same for all patients which naturally led to the unanimous agreement. The same operator and assessors were used in every operation, creating familiarity with the process and removed the potential for poor interrater reliability.

A total of 11 of the 15 patients (73%) had a successful first TROC (S1TROC) in the ward and 11 of the 14 patients who completed follow-up (79%) were catheter free by follow up (CFF). Age, ethnicity, ASA and pre-TURP catheter type were similar for successful versus unsuccessful first TROC and CFF (Table 1). Average post-operative on-table VS were higher for successful compared to the unsuccessful TROC group: 3.9 versus 2.5, respectively. Similarly, those patients who were catheter free by follow up had higher average post-operative scores (4.1) than those who were catheter dependent (1.3). The change in VS (post-TURP score minus pre-TURP score), was higher for successful versus unsuccessful TROC (2.4 versus 1.3) and catheter free by follow up versus catheter dependent (2.5 versus 0.3).

Three variables were assessed for their outcome predictability with ROC analysis: post-operative VS, change in VS and combination VS. Figure S1 shows the ROC curve for S1TROC. The AUC's for combination score, post-operative score and change in VS as 0.85, 0.84 and 0.72, respectively. The best cut-off value for post-operative VS was ≥4 and showed a sensitivity 0.91, specificity 0.75, PPV 0.91 and NPV 0.75. The best cut-off value for change in VS was ≥2 and showed a sensitivity 0.73, specificity 0.75, PPV 0.89 and NPV 0.50. Finally, the best combination score cut-off was ≥6 with sensitivity 0.82, specificity 0.75, PPV 0.90 and NPV 0.60.

ROC analysis for CFF (Fig. S2) calculated AUC for combination score, post-operative VS and change in VS as 0.94, 0.91 and 0.85, respectively. The best cut-off value for post-operative score was ≥3 and showed a sensitivity 1.0, specificity 0.67, PPV 0.91 and NPV 1.0. The best cut-off value for change in VS was ≥1 and showed a sensitivity 0.91, specificity 0.67, PPV 0.91 and NPV 0.67. Finally, the best combination score cut-off was ≥6 with sensitivity 0.82, specificity 1.0, PPV 1.0 and NPV 0.6.

The overall best cut-off for predictability was Combined Score ≥6 which, for S1TROC; showed a sensitivity 0.82, specificity 0.75, PPV 0.9 and NPV 0.6. Therefore, successfully predicted 82% (9/11) of those with S1TROC and predicted 75% (3/4) non-successful first TROC. It had slightly improved predictability with long term outcome. For CFF it showed a sensitivity 0.82, specificity 1.0, PPV 1.0 and NPV 0.6. Therefore, predicting 82% (9/11) of those CFF and catheter dependent 100% (3/3).

Case examples in clinical practice: Patient 1 was predicted to fail his first TROC by Chambers test and he did. He was deemed to have significant adenoma volume remaining after 60 min of resection. After a repeat TURP during a second admission his Chambers test improved dramatically, he was predicted to pass his S1TROC and he did. He was also CFF. Patients 2 and 3 both had catheters in for several months prior to their operation. With their preoperative consent, SPC insertion was done simultaneously at the time of TURP. Chambers test predicted them to fail their TROC. It was deemed no further adenoma could be resected. Both did fail and were catheter dependent. They continue to use their SPC and avoided further operations.

Table 1 Baseline patient characteristics and primary catheter outcomes

		Total ($n = 15$)	Trial removal of catheter		Catheter free by follow-up	
			Successful ($n = 11$)	Unsuccessful ($n = 4$)	Yes ($n = 11$)	No ($n = 3$)
Age	Mean (Range)	72 (61–88)	71	74	72	72
	60–69	7				
	70–79	6				
	80+	2				
Ethnicity						
	NZ European	14	11	3	10	3
	Asian	1	0	1	1	0
ASA	Mean (Range)	2.5 (2–4)	2.7	2	2.5	2.3
Comorbidity	Heart disease	6				
	Lung disease	2				
	Both	2				
	Significant other	7				
Pre-TURP catheter						
	Urethral	14	10	4	10	3
	Suprapubic	1	1	0	1	0

Discussion

This feasibility study assessing the accuracy and usefulness of the Chambers Test, has demonstrated it to be quick and easy to perform while utilizing minimal resources. It has proven to be effective in predicting catheter outcomes post-TURP with a high degree of accuracy in our patient sample. Using the Chambers Test, we identified VS thresholds to accurately predict S1TROC and CFF outcomes, with sensitivity and specificity values ranging from 73–91% to 67–100%, respectively. We successfully identified patients who may require repeat intervention: Chambers Test accurately predicted 82% of those patients' catheter-free post-TURP and 100% of those who were catheter-dependent.

We suggest all TURP should be followed by the Chambers Test. In those predicted to do poorly, this generates a clinical decision: Put the scope back in and assess the bladder outlet for residual obstructing prostate tissue:

(1) If on inspection the bladder outlet is wide open with no residual tissue to be resected then end the procedure and place an SPC (if intermittent self-catherization is not an option and in individuals with multiple co-morbidities, advanced age/frailty and those who repeated operative management carries significant risk).
(2) If on inspection there is more tissue to be resected and TUR-time has not exceeded 60 min, then proceed with further resection.
(3) If on inspection there is more tissue to be resected but TUR-time has exceeded 60 min then document the presence of remaining adenoma, end the procedure and if patient fails TROC then book for re-TURP.

New Zealand, like many countries, has a health system under pressure. Surgical services are relatively under-resourced.[10] With increasing prevalence of elderly males with urinary symptoms and comorbidities,[2,3] we can expect an increase in TURP demand.[1] Investigations creating surgical efficiency, correctly identifying patients that get maximal benefit from TURP-related resources while minimizing risk and the incidence of further operations, should be utilized. This simple, reproducible technique may be of value specifically in resource constrained settings challenged by reduced access to urodynamics. Against this backdrop, having a reliable intra-operative method of predicting successful outcomes after TURP would have numerous benefits.

Firstly, it can be used to identify patients needing further resection within the index surgery session, avoiding the need for a repeat admission, anaesthetic and surgery. Secondly, this could allow for the identification of those patients with detrusor underactivity, poor bladder contractility or other non-obstructive pathology who remain unable to empty their bladders adequately despite TURP. A comorbid subset of this group would therefore benefit from a permanent suprapubic catheter (if placement of a permanent SPC had been included in the pre-TURP informed consent process), this avoids the need for a second procedure.

Pre-operative factors that have diagnostic value in predicting the outcome after TURP have been described. A meta-analysis by Kim *et al*. in 2017 indicated that men with a diagnosis of BOO on UDS pre-TURP had bigger improvements in IPSS scores, quality of life scores, uroflowometry and post-void residual volumes compared to those who did not.[11] Similarly, a meta-analysis by the same authors, showed urodynamic detrusor underactivity (DU) had poorer outcomes post-TURP for BPH.[12] Ultrasonic factors relating to resistive index, transition zone index, detrusor wall thickness and bladder weight estimation also correlated with efficacy outcomes.[7] Unfortunately, performing UDS on all men before TURP is problematic: UDS is relatively invasive, it can be associated with significant cost and may not be accessible to all centres. Our own centre requires a referral to a second centre for UDS to be performed; creating long wait times, delaying definitive treatment, increased costs and increasing patient anxiety. Various studies have advocated against routine pre-operative UDS because acontractile and underactive bladders exhibit an element of bladder recovery and improved voiding as a result of BOO being attenuated.[13–15] The UPSTREAM study showed UDS did not change rates of BOO surgery, was more expensive and symptom outcome did not differ between groups. This provides a contemporary analysis supporting evidence against the routine use of UDS.[16] Therefore, it is generally accepted to offer TURP to men with DU who clinically may have an element of BOO. In this group of men, Chambers Test could identify who will still be IDUC-dependent despite TURP, thereby beneficial to co-morbid patients requiring SPC.

The Young Academic Urologists' benign prostatic obstruction nomogram[17] uses maximum flow scores and ultrasound derived transition zone volume to predict outcomes. Higher nomogram probability scores achieved an AUC of 0.77.[17] In comparison, Chambers Test requires no preoperative imaging, only standard TURP equipment and our best threshold, Combination Score AUC of 0.85 and 0.94 for S1TROC and CFF outcomes, respectively.

Limitations and recommendations for a pilot study

The size of our study reflects its nature as a Feasibility study, with its primary aim to ascertain if Chambers test methodology could be performed in a reproducible and feasible manner. An interventional study with an initial pilot involving a larger sample size based on power calculation in accordance with STARD statement,[18] would be the next step to verify the diagnostic accuracy of the Chambers Test. Confidence intervals and statistical significance would then have relevance. Definitive conclusions on Chambers Test effectiveness cannot be made based on our patient sample. In our study, consecutive recruitment was chosen to minimize selection bias, however several participants did not make it to the analysis because of not being consented, episodic unavailability of dual assessors and unfamiliarity of the process among theatre staff. Education sessions within the department for staff involved and the training of more than two assessors would potentially mitigate these factors.

In a follow-up, larger scale study, it would be essential to monitor abdominal pressure reproducibility throughout the study to make sure that a standardized abdominal pressure is generated consistently. A more accurate and verifiable method of applying a predetermined abdominal pressure would be essential if more than one operator performed the test. We would suggest the use of a small

calibre pressure-transducer catheter that measures intravesical pressure for objective monitoring in conjunction with uroflowmetry. Our feasibility study used a subjective measurement scale. Using dual assessors and unanimous agreement of VS we attempted to make it more objective. However, to ensure objectivity and removal of inter-observer bias, we would strongly recommend using a portable uroflowmetry device in the operating theatre to objectively measure flow rate in future studies.

Chambers Test methodology does rely on relief of the mechanical component of BOO. Therefore, DU possibly acts as a confounder and may alter the predictability of Chambers Test. However, a large 'baggy' bladder filled with a set volume and compressed with a set-pressure may still lead to poor flow due to the distribution of fluid in the patulous bladder. This would be of interest for further adequately powered studies, if Chambers Test with alternative bladder filling volumes could more accurately predict a provisional diagnosis of DU. In this regard, performing the Chambers Test using radiological contrast medium in the bladder combined with fluoroscopy, may yield valuable anatomical information. Post-operative UDS could then confirm the diagnosis but would be unlikely to change long-term management.

The type of anaesthesia, use of muscle relaxant, BMI, prostate size, detrusor activity, distal sphincter tone and duration of pre-TURP IDUC may impact the performance of Chambers Test scores. A large-scale study with higher patient numbers and randomisation would allow sub-group and multivariate analyses to assess this.

Conclusions

This feasibility study has found Chambers Test to be a simple, reproducible and fast intra-operative technique to assess urinary flow before- and after TURP. We have demonstrated its use in a standardized format using only the equipment necessary for a standard monopolar TURP. In the present study it accurately predicted successful catheter free outcomes as well as long term catheter dependence. This technique could create an efficient change in management by recognizing those patients requiring further prostate resection and those in whom simultaneous SPC insertion should be considered. Further large scale studies using objectively measured abdominal pressure and flow rates during Chambers Test are needed.

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Author contributions

Christian Robinson: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing – original draft; writing – review and editing. **Alastair Hepburn:** Conceptualization; data curation; investigation; methodology; project administration; supervision; validation; writing – review and editing. **Robin Turner:** Formal analysis; software; supervision; writing – review and editing. **Amir Zarrabi:** Methodology; supervision; writing – review and editing.

Conflict of interest

None declared.

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Informed consent

Written informed consent was obtained from all subjects before the study.

Ethical approval

Ethical approval for this study was obtained from Southern Health and Disability Ethics Committee. 18/STH/171.

Trial registration

Australian New Zealand Clinical Trials Registry. ACTRN12618001967279.

Guarantor

Christian Robinson.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure S1. ROC analysis outcomes predicting Successful 1st TROC.
Figure S2. ROC analysis outcomes predicting catheter free by follow up.