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ORIGINAL PAPER

# The use of urodynamic to assess the mechanism of incontinence in patients with Yang-Monti based catheterizable cutaneous stomas

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**Summary** *Objective: To analyze the static and dynamic urodynamic parameters of reservoirs and continent conduits in continent cutaneous urinary diversion with catheterizable stoma.*

*Materials and methods: 76 patients had augmented ileocystoplasty or continent urinary diversion with catheterizable urinary stoma based on Mitrofanoff principle and Yang-Monti procedure using subserous tunnel as continence mechanism. They were followed up for at least 6 months post-operatively for continence through stoma and divided into two groups (continents vs non-continent) according to stomal continence. Both groups had urodynamic assessment performed via the stoma to assess reservoir capacity, pressure and contractions, efferent limb functional length, reservoir overactivity, static and dynamic maximal closure pressures and leak point pressure.*

*Results: Continence rate was 87%. Continent group included 66 patients and incontinent group included 10 patients. In both groups at rest, the reservoir pressure after filling did not exceed 25 cm H2O. During peristaltic contraction, the pressure did not exceed 30 cm H2O and the duct remained continent. After Valsalva maneuver, the reservoir pressure increased up to 34 (+ 7.4) cm H2O and leakage occur in 10 patients (13%). Reservoir (wall) overactivity was recorded in 54 patients, with insignificant rise in intraluminal pressure during the contractions. In both groups, the efferent tract closing pressure was always higher than the reservoir pressure. The mean of maximal closing pressure at Valsalva was 82.5 (+ 4.18) cm H2O in the continent group and 61.66 (+ 8.16) cm H2O in the incontinent group. The mean functional length of the conduit was 4.95 + 1.62 in the continent group and 2.80 + 1.50 cm in the incontinent group.*

*Conclusions: Urodynamic evaluation of continent catheterizable cutaneous stoma after Yang-Monti procedure has a practical significance. Functional length of the conduit seems to be the most influential factor for continence reflecting static & dynamic maximal closure pressure. Higher conduit closing pressure is associated with better continence. Contractions of the pouch and peristaltic contraction of the conduit has no effect on continence mechanism.*

KEY WORDS: *Incontinence; Urodynamic; Urinary diversion.*

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## INTRODUCTION

Continent cutaneous diversion has proven to be an effective way of urinary diversion. *Yang-Monti* ileovesicostomy technique uses ileal segment as a conduit instead of appendix as originally described in Mitrofanoff principle if appendix is not accessible. Urodynamic is a clinical test or a series of clinical tests used to describe the current function or dysfunction of the lower urinary tract. In theory and in practice, the clinician utilizes the results of urodynamic testing to direct therapy whether surgical, medical, or behavioral alone or in combination. Current methods include water filled urodynamic, ambulatory urodynamic, and video urodynamic. Regardless of the method, urodynamic examines the functional anatomy of the bladder or urethra or both and their response to filling, storing, and voiding (1). Urodynamic testing is an important tool in urology providing objective descriptions concerning the patient's incontinence and voiding dysfunction (2). Therefore, the objectives of this study was to analyze the static and dynamic urodynamic parameters of the reservoir and conduit affecting continence after continent cutaneous urinary diversion with catheterizable stoma using *Yang-Monti* technique.

## MATERIALS AND METHODS

Between June 2018 and May 2023, 76 patients who had continent urinary diversion and catheterizable urinary stoma based on *Mitrofanoff* principle and *Yang-Monti* tech-

nique in the institution of the Authors were included in this study and prospectively studied and followed up post-operatively for continence through the stoma for a minimum of 6 months. The mean age of the patients at time of surgery was 19 years (5-59 years); 51 patients were males and 25 patients were females. The indications for continent diversion were (neurogenic bladder in 59 patients, bladder cancer in 13 patients, and congenital anomalies in 4 patients). Sixty-one cases had augmented ileocystoplasty with a patch of detubularised ileum and 15 cases had their native bladder replaced by intestinal reservoir. An ileal segment with average length of 45 cm was detubularised and used as a reconfigured spherical reservoir for the ileovesicostomy procedure. Surgery for bladder neck closure was performed in 37 patients of the augmented group. The patients were divided into two groups according to stomal continence.

Both groups had ascending pouchography and urodynamic study assessment performed via the stoma to assess reservoir capacity, pressure and contractions, efferent limb functional length, overactivity, static and dynamic maximal closure pressures and leak point pressure. The assessment was performed 15 days after the withdrawal of anticholinergic drugs and treatment of urinary tract infection. The patients who presented with reflux are excluded. State of continence was documented at 6 months and every 3 months later till end of the study. Mean follow up period was 30.6 months (ranging from 9 to 48 months).

Urodynamic study was performed using a trans-stomal 6 French dual catheter and a 14 French rectal balloon catheter for pouchometry and pressure profilometry of the efferent tract. The rate of filling used was 50 ml/minute and the capacity measured at sense of discomfort or notice of leakage. The withdrawal of sensors was done with an electric arm at a speed of 2 ml/min. The static profile maximum closure pressure of the efferent limb was obtained by subtracting the baseline (empty) reservoir pressure from the maximum inner pressure of the efferent limb. The catheter was again passed into the reservoir and the side hole of the catheter was manually positioned at the point of the static profile maximal closure pressure of the conduit. The pouch was filled and the response of the conduit pressure to a reservoir contraction and/or abdominal strain (cough or Crede) was recorded. The presence of involuntary reservoir contractions or conduit leak was noted. Abrupt increase in conduit pressure without simultaneous changes in reservoir or abdominal pressure was considered evidence of peristaltic activity of the conduit. The dynamic profile maximal reservoir pressure was recorded, and dynamic profile maximal closure pressure of the efferent limb was derived by subtracting the greatest filling phase conduit pressure from simultaneous reservoir pressure. Leak point pressure, compliance and reservoir capacity were evaluated. The functional length of the efferent limb was defined as the continuous length of the efferent limb in which the pressure was higher than the reservoir pressure.

### *Ethical approval and consent for participation*

All procedures performed in this study complied with institutional and/or national research council ethical standards as well as the 1964 Declaration of Helsinki and its subsequent amendments or similar ethical standards. Protocols and written informed consent for all participants were approved by the *Research Ethics Committee of Thumbay University Hospital* (affiliated with Gulf Medical University, REC #: 52/2018).

### *Statistical methods*

Demographic data, reservoir capacity, functional length, closure pressures were reported using mean + standard deviation (SD). Differences in means were assessed by Student t test for significance. Correlation among the continuous variables was analyzed using Pearson correlation coefficient. Dichotomous variables as continence status, contractions, functional length greater than 2.0 cm versus less were analyzed using Chi-square test.

## RESULTS

Continence rate was 87%. Continent group included 66 patients and incontinent group included 10 patients.

No major surgical complications or mortality observed in the study. Stomal complications were observed in 4 patients in form of stomal stenosis in 2 patients and difficult catheterization in further 2 patients. Surgical revision was performed for 7 patients; in the 4 cases with stomal complications other than incontinence and in 3 cases with incontinence that were treated with injection of bulking agents with 2 successes and 1 failure after submucosal injection of bulking agent. The rest of the incontinent group were managed by frequent catheterization.

The capacity of the reservoir was 496.8 (+180.27) ml (range 100-900). It was smaller in the incontinent group without a statistically significant difference. In both groups, the reservoir pressure at rest after filling did not exceed 25 CmH2O; the mean value was 20.72+6.05 cmH2O with no significant difference between continent and incontinent groups (Table 1). Peristaltic contractions of the reservoir were noted in 6 cases. During contractions, the pressure did not exceed 30 CmH2O and the duct remained continent. After Valsalva maneuver, the reservoir pressure increased up to 41.4 CmH2O without significant difference between continence groups (Table 1) and leakage occur in 10 patients. All patients had positive static and dynamic maximal conduit closure pressures. In every case the dynamic was greater than the static pressure reflecting a positive conduit to reservoir pressure gradient as the reservoir was filled to its capacity. The mean static and dynamic maximal closure pressures of the incontinent group were lower compared to those of the continent patients but the differences were not statistically significant (Table 1). In both groups, the efferent tract closing pressure was always higher than the reservoir pressure. The mean efferent closing pressure at Valsalva was 82.5 (+ 4.18) CmH2O in the continent group and 61.66 (+ 8.16) CmH2O in the incontinent group which demonstrated a highly significant difference (Table 1). Overactivity was recorded in 54 patients, with insignificant rise in intraluminal pressure during the contractions (Table 2). The mean functional profile length of the conduit was 4.6 + 1.77 cm (ranging from 1.7 cm to 7.5 cm) and was correlated positively to continence status (Table 3). The mean functional length of the continent and incontinent groups were 4.95 (+1.62) cm and 2.80 (+1.50) cm respectively with a highly significant difference (Table 1). All the

***Table 1.***
*Urodynamic data of the continent group in comparison to incontinent group.*

| | Continent group | Incontinent group | p-value |
|---|---|---|---|
| Reservoir capacity | 500.95 + 182.64 ml | 475.00 + 191.92 ml | 0.79 |
| Reservoir pressure after filling | 18.92 + 5.08 CmH20 | 21.72 + 3.05 CmH20 | 0.8 |
| Reservoir pressure after Valsalva | 30 + 5.6 CmH20 | 34 + 7.4 CmH20 | 0.86 |
| Efferent closing pressures | 82.50 + 4.18 CmH20 | 61.66 + 8.16 CmH20 | < 0.001 |
| Functional length | 4.95 + 1.62 cm | 2.80 + 1.50 cm | < 0.001 |
| Static maximal closure pressure | 46.50 + 12.66 | 38.90 + 10.12 | 0.197 |
| Dynamic maximal closure pressure | 68.75 + 8.53 | 66.90 + 11.88 | 0.771 |

***Table 2.***
*Intraluminal pressure in contracted reservoir versus non-contracted.*

| Groups | No. of patients | Mean pressure + SD | p value |
|---|---|---|---|
| No contractions | 54 | 19.8 + 6.58 | 0.363 |
| Reservoir contractions | 22 | 22.1 + 5.17 | |

patients with conduit functional profile length of 2 cm or less were incontinent. Further analysis of patients with functional length lower than 2 cm revealed a lower static profile maximal closure pressure compared to those with a functional profile length of greater than 2 cm. Also, functional length was positively correlated to dynamic closure pressure (Table 4). Conduit peristalsis was observed in 29 patients. However, there was no statistically significant difference between incidence of conduit peristalsis in continent (23 patients/66) and incontinent (6 patients/10), by the measurement of functional profile length, static or dynamic maximal closure pressure (Table 5).

***Table 3.***
*Correlation between functional length and continence status.*

| | Functional length | Continence |
|---|---|---|
| Pearson correlation | 0.454 * | 1 |
| Significance (2-tailed) | 0.22 | |

** Correlation is significant at the 0.05 level.*

***Table 4.***
*Correlations between functional length and maximal closure pressure.*

| | | Dynamic | Static |
|---|---|---|---|
| Functional length | r | .522** | .056 |
| | p value | .007 | .790 |
| | N | 25 | 25 |

***Table 5.***
*Conduit peristaltic contraction in relation to urodynamic data.*

| Groups | | Mean + SD | t | p value |
|---|---|---|---|---|
| Static | No peristalsis<br>Peristalsis | 38.41+ 9.238<br>41.69 + 11.967 | 0.76 | 0.45 |
| Dynamic | No peristalsis<br>Peristalsis | 66.66 + 11.934<br>67.69 + 11.108 | 0.22 | 0.82 |
| Functional length | No peristalsis<br>Peristalsis | 4.26 + 2.039<br>4.92 + 1.497 | 092 | 0.36 |

In our study, one patient was managed by surgical elongation of the tunnel and become completely dry on five hours interval between catheterization.

## Discussion

*Mitrofanoff* principle was described to achieve continent urinary diversion through an appendiceal stoma in cases of compromised vesico-urethral function with inaccessible urethra (3). An alternative approach (*Yang-Monti* technique) using an opened ileal segment closed transversely was described later when the appendix could not be used or preserved for *Malone antegrade enema procedure* (MACE) (4). The *Monti* ileovesicostomy has become an integral component of lower urinary tract reconstruction and more recently laparoscopic and robotically assisted techniques have been described also (5, 6).

In the present study, the continence rate was 87%, that is lower than those achieved by studies which used appendicovesicostomy with continence rates ranging from 91 to 96% (7-9). Other studies on *Monti* technique suggested continence rates comparable to appendicovesicostomy (10). This result may be attributed to the high conduit intraluminal pressure achieved by appendiceal stoma (11) or inadequate surgical technique as inadequate flap valve mechanism, internal fistula or inadequate reservoir (12). The reservoir capacity was adequate in most cases with a mean cystometric capacity at 6 months of 496 ml due to detubularisation. Smaller reservoir capacity was observed in incontinent group but without statistical significance, although seven patients of the incontinent group showed a capacity of 250-300 ml. These patients had to catheterize their pouch every two hours to avoid urine leak and during nighttime, an indwelling catheter had to be placed to avoid sleep interruption. The incontinence in the other three patients with adequate capacity can be explained by insufficient tunnel length, inadequate fixation of efferent channel to rectus sheath or angulation. One patient was managed by surgical elongation of the tunnel becoming completely dry at five hours interval between catheterizations. Two cases were managed by submucosal injection of bulking agent which achieved temporary continence only for 2 months and required subsequent revision of the conduit to regain continence. These results support poor results observed in literature for bulking agent injection in ileal stomal incontinence (13, 14). Stomal complications in this study were minimal (5.2%) in comparison to results of appendicovesicostomy observed in literature (15) and better than reports of other studies that suggested same rate of stomal complications for *Monti* technique compared to appendicovesicostomy (11 to 19%) (10). The urodynamic study at rest showed low reservoir pressure due to detubularisation which delays and reduces the amplitude of the pressure rise caused by partial contractions and consequently accommodates higher volumes and prevents leakage. Detrusor overactivity was detected in many patients but did not cause a significant rise in the reservoir pressure or associated leakage. The conduit pressure was an important factor contributing in efficacy of continent catheterizable stomas, being the higher the conduit pressure, the more the continence mechanism. The mean static and dynamic closure pressure of the conduit were lower in

incontinent cases but the difference was not statistically significant. These results are similar to the results achieved by other studies (11, 16). The efferent tract closing pressure (with full reservoir) in our study was 75 CmH2O. This result is similar to the result obtained by appendicovesicostomy. However, most long-term studies supported durable results of appendicovesicostomy (11) where this is still to be proven for ileovesicostomy by future long term studies. The mean functional length was 4.6 cm and it showed a highly significant difference between continent and incontinent group. Although static and dynamic closure pressures were not significantly different between continent and incontinent groups, there was a significant correlation between functional length and the maximum closure pressure. Thus, the cause of incontinence can be attributed to length of the conduit more than reservoir capacity. Strong peristaltic contractions of the conduits were demonstrated in some individuals but the overall effect of these pressure waves did not correlated with clinical continence or with any other urodynamic factor.

## Conclusions

Urodynamic evaluation of continent catheterizable cutaneous stoma after *Yang-Monti* procedure has a practical significance. Functional length of the conduit seems to be the most influential factor for continence reflecting static and dynamic maximal closure pressure. Higher conduit closing pressure is associated with better continence. Contractions of the pouch and peristaltic contraction of the conduit has no effect on continence mechanism.

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## References

*1. Abouelgreed T, Saleh D, Abdelaal M, et al. Urodynamic changes following laparoscopic versus vaginal hysterectomy. Arch Ital Urol Androl. 2022; 94:315-318.*

*2. Kupec T, Pecks U, Gräf CM, et al. Size Does Not Make the Difference: 3D/4D Transperineal Sonographic Measurements of the Female Urethra in the Assessment of Urinary Incontinence Subtypes. Biomed Res Int. 2016; 2016:1810352.*

*3. Ramanan V, Kapoor R, Srinadh ES, et al. Mitrofanoff principle for continent urinary diversion.Urol Int. 1997; 58:108-112.*

*4. Monti PR, de Carvalho JR. Transverse tubulization of intestinal segments: a catheterizable conduit as an alternative to the Mitrofanoff procedure. Prog Urol. 2001; 11:382-384.*

*5. Thakre AA, Yeung CK, Peters C. Robot-assisted Mitrofanoff and Malone antegrade continence enema reconstruction using divided appendix. J Endourol. 2008; 22:2393-2396.*

*6. Wille MA, Zagaja GP, Shalhav AL, Gundeti MS. Continence outcomes in patients undergoing robotic assisted laparoscopic mitrofanoff appendico-vesicostomy. J Urol. 2011; 185:1438-1443.*

*7. Elshal AM, Abol-Enein H, Sarhan O, et al. Catheterizable serous lined urinary outlet in children and adolescents: a choice when other treatments fail. J Urol. 2011; 185:1083-1087.*

*8. Mhiri MN, Bahloul A, Chabchoub K. Mitrofanoff appendicovesicostomy in children: indication and results. Prog Urol. 2007; 17:245-249.*

*9. Surer I, Ferrer FA, Baker LA, Gearhart JP. Continent urinary diversion and the exstrophy-epispadias complex. J Urol. 2003; 169:1102-1105.*

*10. Clark T, Pope JC 4th, Adams mC, et al. Factors that influence outcomes of the Mitrofanoff and Malone antegrade continence enema reconstructive procedures in children. J Urol. 2002; 168:1537-1540.*

*11. Chabchoub K, Ketata H, Fakhfakh H, et al. Continent urinary diversion (Mitrofanoff principle). Physical mechanisms and urodynamic explanation of continence. Prog Urol. 2008; 18:120-124.*

*12. Cain MP, Andrew MD, Anthany JG, et al. Updated experience with the Monti catheterizable channel. Pediatric Urology 2008; 72:782-785.*

*13. Gowda BO, Agrawal V, Harrison SC. The continent catheterizable abdominal conduit in adult urological practice. BJU Int; 2008; 102:1688-1692.*

*14. Welk BK, Afshar K, Rapoport D, MacNeily AE. Complications of the catheterizable channel following continent urinary diversion: Their nature and timing. J Urol 2008; 180:1856-1860.*

*15. Van der AF, Joniau S, De Baets K, De Ridder D. Continent catheterizable vesicostomy in an adult population: success at high costs. Neurourol Urodyn. 2009; 28:487-4891.*

*16. Watson HS, Bauer SB, Peters CA, et al. Comparative urodynamics of appendiceal and ureteral Mitrofanoff conduits in children. J Urol 1995; 154:878-882.*

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**Conflict of interest:** The authors declare no potential conflict of interest.