

THE URODYNAMIC FEATURES OF ORTHOTOPIC ILEAL RESERVOIRS: A COMPARISON BETWEEN HEMI-KOCK POUCH AND "W" NEOBLADDER

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ABSTRACT

This study was carried out to evaluate the urodynamic characteristics of the hemi-Kock and "W"-configured ileal reservoirs utilized for orthotopic urinary diversion after radical cystoprostatectomy in our center. One hundred patients (52 with hemi-Kock and 48 with "W" neobladders) who were free of stones, strictures or reflux after one year of follow-up were evaluated. Clinical and bacteriological examinations were done for every case. Radiological evaluation was done prior to inclusion of the patient in the study to exclude the presence of pouch stones, strictures of the urethra or pouch-ureteral reflux. Urodynamic studies were done including uroflowmetry, medium-fill enterocystometry and urethral pressure profilometry. A univariate analysis showed a comparable outcome of both reservoirs regarding continence rate, voiding efficiency and bacteriological studies. The enterocystometric characteristics were comparable in both groups except for two variables. The pressure at maximum pouchometric capacity was significantly higher in the hemi-Kock pouch (mean 26.7 ± 10.8 cm H₂O) than in the "W" neobladder (mean 21.7 ± 10.7 cm H₂O) ($P=0.02$). Also, the compliance in the last 5 minutes of filling was significantly less in the hemi-Kock pouch (mean 28.3 ± 14.5 ml/cm water) than in the "W" neobladder (mean 40.5 ± 24.9 ml/cm water) ($P=0.003$). The urethral pressure profiles as well as flow rates of "W" and hemi-Kock pouches (16.7 ± 8.3 and 17.7 ± 7.4 ml/second, respectively) were also comparable. We conclude that both types of reservoirs have near optimum urodynamic properties with an excellent functional outcome. There are few pouchometric differences which, in our study, did not affect the functional outcome of the procedure.

INTRODUCTION

Orthotopic bladder substitution in men provides an excellent functional outcome following radical cystectomy in terms of preservation of the upper urinary tract, maintenance of a high rate of continence and an accepted low rate of morbidity^{1,2}. This has led to an increased application of this type of bladder substitution in patients with invasive bladder carcinoma; in fact, only patients with a positive urethral cut margin for malignancy have to be excluded².

The necessity of detubularization and reconfiguration of the utilized intestinal segments to ensure the achievement of such excellent outcome has been well recognized and has been supported mathematically^{3,4}, experimentally^{5,6} and clinically by many authors who reported urodynamic and functional superiority of their detubularized techniques, whether ileal^{1,2,7,8,9} or colonic¹⁰⁻¹³. Furthermore, authors who had initially adopted the tubular techniques, modified their techniques later on to avoid a high reservoir pressure com-

Table 1: Residual Urine in the Types of Reservoirs

Volume of residual urine	Hemi-Kock Pouch n=52	W-Neobladder n=48	P-value
No residual urine	41	32	0.174
50-150 ml	6	9	0.471
> 150 ml	5	8	0.211

promising their functional results, either by detubularization, ileal patching or by transverse taeniamyotomies¹⁴⁻¹⁷.

The question as to which intestinal segment should be used for the construction of the reservoir, its type and its length is still being debated. Each segment has its enthusiasts and its opponents depending on many factors including anatomical accessibility, the surgeon's preference, inherent physiologic characteristics of each segment and the possible complications resulting from the resection of the segment and/or its incorporation in the urinary tract^{1,18}. However, enterocystometric evaluation of detubularized reservoirs of different bowel segments showed higher basal pressures^{7-9,11,13} with a higher frequency and amplitude of uninhibited contractions in colonic reservoirs compared to ileal reservoirs^{11,13,19-21}.

In the present study, we evaluated the urodynamic features of the two most commonly used intestinal urinary reservoirs in our center: the hemi-Kock and "W" neobladders.

PATIENTS AND METHODS

Between 1986 and 2000, over 700 male patients were subjected to radical cystectomy and orthotopic ileal reservoirs in the form of hemi-Kock or "W"-neobladder at the Mansoura Urology and Nephrology Center. Radical cystoprostatectomy and urinary reservoirs were done as described previously^{1,22,23}. In both types of reservoirs we used 40 cm of the ileum. The first coming 100 patients with orthotopic reservoirs who were free of stones, strictures or reflux that might adversely affect reservoir function were evaluated. Fifty-two out of these 100 patients had hemi-Kock pouches (Group 1), while 48 had "W"-neobladders (Group 2). The mean age of the patients of Group 1 was 50.2±8.1 years (range 30 to 67years) which

was comparable to a mean age of 48.8±8.5 years (range 33 to 67 years) in Group 2. The mean follow-up period in Group 1 was 36.6±28 months (range 12 to 96 months) which was significantly longer than the follow-up of the patients in Group 2 (17.5±6.9 months, range 12 to 36 months).

All patients were evaluated by history and clinical examination to exclude local pelvic recurrence or chronic urine retention. Urine samples were obtained for culture and sensitivity. Radiological assessment was done by plain X-ray of the urinary tract, ascending pouchogram, micturition studies and post-voiding film to exclude the presence of pouch stones, strictures of the urethra or pouch-ureteral reflux.

Urodynamic evaluation by uroflowmetry, medium-fill enterocystometry (20 ml/minute) and urethral pressure profilometry was done for every patient using the Dantec UD 5500 machine (Denmark). The terminology of the urodynamic variables was adopted according to the definitions of the International Continence Society unless otherwise stated^{24,25}. The contraction amplitude and duration were measured at 80% of the enterocystometric capacity. The frequency of uninhibited contractions and compliance was calculated in the last 5 minutes of filling. A statistical analysis was done to compare the data using the student-t test for parametric variables, the Mann-Whitney U-test for non-parametric variables and the Chi-square test for the categorical variables. Differences were considered significant at $P \leq 0.05$.

RESULTS

Complete daytime continence was achieved in comparable numbers of patients in both groups (92% in Group 1 and 94% in Group 2).

Table 2: Organisms Isolated from Urine Culture of Patients with Hemi-Kock and "W" Neobladders

Organisms	Hemi-Kock Pouch (n=52) No. of Patients	"W" Neobladder (n=48) No. of Patients	Total Cases (n=100) No. of Patients
Escherichia coli	7	8	15
Pseudomonas aeruginosa	4	5	9
Klebsiella pneumoniae	4	4	8
Proteus mirabilis	3	4	7
Others	6	6	12
	24	27	51

Table 3: Uroflowmetric Characteristics of Patients of Both Groups

Variable	Hemi-Kock Pouch (n=52) Mean \pm SD	"W" Neobladder (n=48) Mean \pm SD	P-Value
Average flow rate (ml/second)	7.61 \pm 4.26	7.60 \pm 4.25	0.989
Maximum flow rate (ml/second)	17.65 \pm 7.43	16.65 \pm 8.27	0.525
Voided volume (ml)	366.10 \pm 147.94	401.19 \pm 177.08	0.283
Time to max. Flow (seconds)	26.56 \pm 22.94	32.33 \pm 32.54	0.505
Flow time	50.90 \pm 24.71	60.10 \pm 34.43	0.126
Voiding time	82.79 \pm 50.44	89.90 \pm 54.27	0.532

Nocturnal continence was achieved in 37 hemi-Kock patients (71.2%) which was comparable to 75% (36/48) of the patients with "W"-neobladder. Satisfactory voiding with no significant residual urine volume (< 50 cc) was achieved in 78.85% (41/52) of the patients of Group 1 and in 66.7% (32/48) of the patients of Group 2. Such difference was statistically insignificant ($P=0.170$, Chi-square=1.878) as shown in Table 1.

Asymptomatic bacteriuria documented by positive urine cultures was detected in 46.15% (24/52) of the patients of Group 1 (hemi-Kock) which was insignificantly different from an incidence of 56.25% (27/48) in the patients of Group 2 ("W" pouch) ($P=0.31$). The commonest isolated organisms were E. Coli, Pseudomonas aeruginosa, Klebsiella pneumoniae and Proteus mirabilis in that order of frequency (Table 2).

Uroflowmetric characteristics of both groups were comparable with no statistically significant difference (Table 3). The mean maximum flow rate of the hemi-Kock group (17.65 \pm 7.43 ml/second) and that of the "W"-neobladder group (16.65 \pm 8.27 ml/second) both indicate non-obstructed voiding of urine. Patients of both types of reservoirs void by Valsalva's which gives an abdominal pattern of flow curve (Fig. 1). There was a tendency of "W"-neobladder cases to have a larger volume of residual urine (57.29 \pm 83.1 ml) compared to the hemi-Kock patients (37.88 \pm 66.31 ml), but with no statistical significance ($P=0.159$). Furthermore, 8 patients (16.7%) with "W"-neobladder had a significant residual urine volume (≥ 150 ml), while only 5 hemi-Kock pouch patients (9.6%) had such residual volumes ($P=0.295$). There was a fair correlation between residual urine volume and maximum cystometric capacity ($R=0.46$). Furthermore, the residual

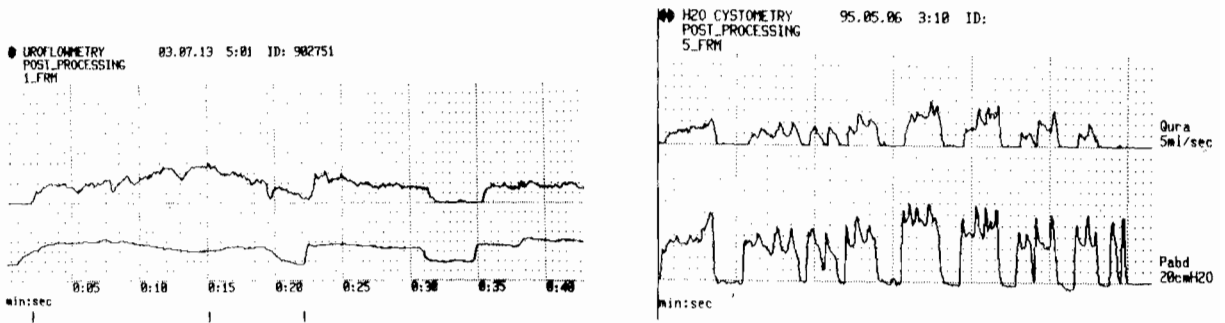


Fig. 1: A: Flow curve of a patient with hemi-Kock pouch. B: Flow curve of a patient with "W"-neobladder. Note the abdominal pattern and good peaks of flow.

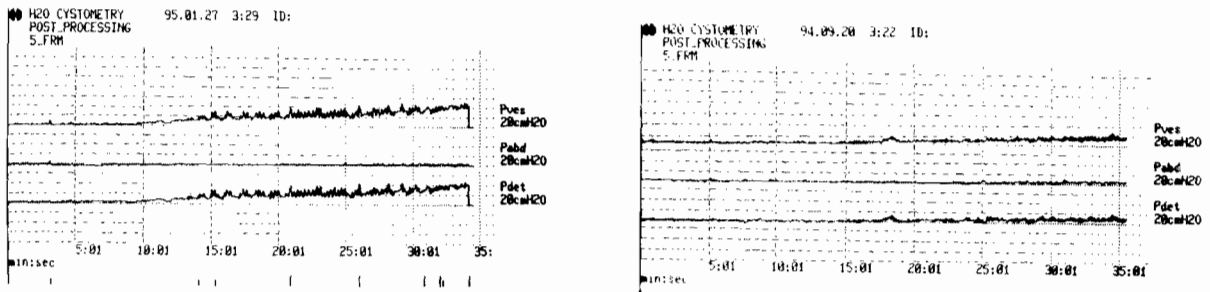


Fig. 2: A: Enterocystometrogram of a patient with hemi-Kock. B: Enterocystometrogram of a patient with "W"-neobladder. Note the more frequent contractions and higher pressure in A.

urine volume also correlated with voiding time ($R=0.56$), flow time ($R=0.41$) and the time to maximum flow ($R=0.36$).

The enterocystometric features of both types of reservoirs were comparable regarding maximum capacity, residual urine volume, pressure at midcapacity, frequency, amplitude and duration of uninhibited segmental contractions and volume at which uninhibited contractions started. The pressure at maximum enterocystometric capacity was significantly higher in the hemi-Kock pouches (mean 26.73 ± 10.78 cm water) than in the "W"-neobladders (mean 21.67 ± 10.71 cm water)

($P=0.021$). Consequently, the compliance of the hemi-Kock pouches (mean 28.28 ± 14.46 ml/cm water) was significantly lower than that of the "W"-neobladders (mean 40.49 ± 24.88 ml/cm water) ($P=0.003$). When we tried to further verify the consistency of such difference by substratifying the patients according to their continence state, we found that the same significant difference regarding pressure at maximum enterocystometric capacity and compliance persisted. However, no such difference was found when we compared patients who had nocturnal enuresis and/or diurnal stress incontinence. Table 4 shows details of the enterocystometric characteristics of both types of

Table 4: Enterocystometric Characteristics of Both Types of Reservoirs

Variable	Hemi-Kock Pouch (n=52) Mean ± SD	"W" Neobladder (n=48) Mean ± SD	P-Value
Residual urine (ml)	37.88±66.31	57.29±83.10	0.159
Maximum capacity (ml)	633.63±165.53	665.50±176.39	0.354
Pressure at midcapacity (cmH ₂ O)	8.94±5.88	8.00±5.34	0.506
Pressure at max. enterocystometric capacity (cmH₂O)	26.73±10.78	21.67±10.71	0.021
Max. amplitude of uninhibited contractions (cmH ₂ O)	3.00±1.28	3.32±1.39	0.370
Frequency of uninhibited contractions (/5 minutes of filling)	34.85±11.22	32.36±1.43	0.455
Duration of uninhibited contractions (second)	49.85±14.24	46.91±13.73	0.428
Compliance ml/cmH₂O	28.28±14.46	40.49±24.88	0.003

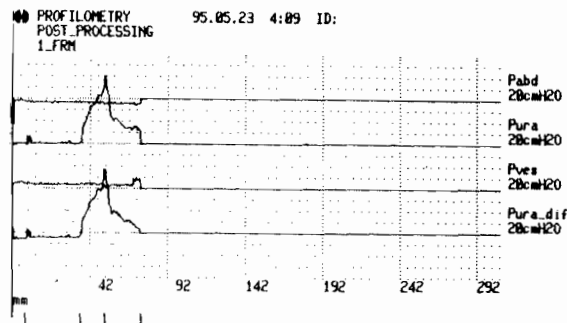
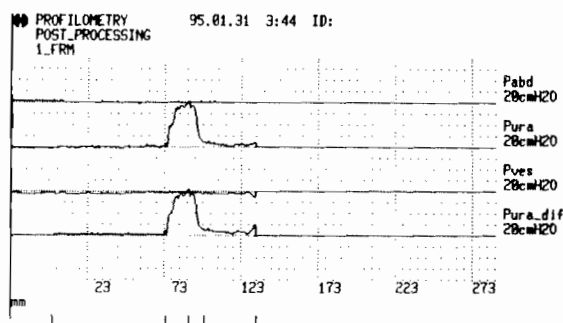


Fig. 3: A: Urethral pressure profile of a patient with hemi-Kock pouch. B: Urethral pressure profile of a patient with "W"-neobladder. Note good functional length and maximum urethral pressure in both patients.

reservoirs. Fig. 2 illustrates the enterocystometrograms of two patients with hemi-Kock and "W"-neobladders.

The urethral pressure profiles of both groups were compared to exclude the sphincteric factor influence on the continence outcome of patients of each type of reservoir. As demonstrated in Table 5, there were no statistically significant differences regarding the maximum urethral pressure or functional urethral length between patients of both types of reservoirs. Fig. 3 shows the urethral pressure

profile of 2 patients with hemi-Kock and "W"-neobladders.

DISCUSSION

Orthotopic bladder substitutes should be detubularized and reconfigured to obtain a neobladder with a good capacity, low pressure and high compliance. This was demonstrated mathematically by Hinman (1988) and Colding and associates (1993), experimentally by Schmidbouer et al. (1987) and Shaaban et al.

Table 5: Urethral Pressure Characteristics of Patients of Both Groups

Variable	Hemi-Kock Pouch (n=52) Mean \pm SD	"W" Neobladder (n=48) Mean \pm SD	P-Value
Functional urethral length (mm)	30.94 \pm 8.36	32.33 \pm 6.63	0.3.61
Maximum urethral pressure (cm H ₂ O)	80.83 \pm 25.09	87.29 \pm 25.85	0.208
Maximum urethral closure pressure (cm H ₂ O)	76.19 \pm 24.82	83.63 \pm 26.19	0.148

(1992) and confirmed by the functional and urodynamic outcomes reported by many authors^{1,2,7-13}. After a thorough review of the different gastrointestinal segments and the various techniques applied to construct urinary reservoirs from such segments, Ghoneim concluded that a short ileal segment (40 cm) configured in the form of hemi-Kock or "W" configuration would yield a reservoir of optimum urodynamic characteristics¹. Nevertheless, few advantages of the ileal "W" neobladder over the hemi-Kock reservoir were noted: no extra bowel segment is required for the construction of a nipple valve, no metallic staples or synthetic material for nipple fixation are required. Consequently, a lower complication rate is anticipated regarding metabolic complications, stone formation and other nipple-related complications²³.

At the Mansoura Urology and Nephrology Center, we can look back to a large series of orthotopic ileal reservoirs constructed for patients subjected to radical cystoprostatectomy for muscle-invasive bladder carcinoma. Out of all evaluable patients, 100 (52 with hemi-Kock pouch and 48 with "W"-neobladders) were evaluated urodynamically. Both types of reservoirs showed excellent enterocystometric criteria. However, three differences were noted: the first one was an insignificant trend of "W"-neobladders to have a larger volume of residual urine. This may be due to the relatively large capacity of the "W"-neobladder resulting from the higher complexity of the "W"-configuration. The existing fair correlation between pouch capacity and residual urine ($R=0.46$) could explain this finding. This was not paralleled by associated obstructed urinary flow rates. However, the existing correlations between residual urine volume and voiding time ($R=0.56$), flow time ($R=0.41$) and time to maximum flow ($R=0.36$) indicate a possible effect of voiding efficiency on the volume of

residual urine. The second and third enterocystometric differences were statistically significant. The hemi-Kock pouches showed a higher pressure at the maximum enterocystometric capacity and less compliance than the "W"-neobladders. Both differences were maintained on substratifying the patient groups according to the continence status so that continent patients of both groups showed the same difference. However, enuretics of both groups showed a similar less favourable urodynamic behaviour. These differences could be explained by the fact that in the hemi-Kock reservoirs only 30 cm of ileum are used for reservoir construction, while the rest is used for valve fashioning. In the "W"-neobladder the total 40 cm of ileum are used for reservoir construction. The extra 10 centimeters of the ileum incorporated may be responsible for such extra compliance and less pressure. A second factor which might be responsible for such difference is the maintained tubular form of the nipple valve and the proximal segment into which the ureters are implanted. When studying the urodynamic behaviour of the supravulvar part in comparison to that of the reservoir, Friedhelm and associates found that although the baseline pressure of both compartments was directly related, yet the amplitude of the pressure waves in the supravulvar part demonstrated a different behaviour tending to increase after half of the reservoir capacity. Microrefluxes could be observed when the upper compartment pressure exceeded 30 cm water²⁶. Such higher pressure of the proximal compartment could be transmitted to the pouch. Valve-related problems such as encrustations, sliding valve or infection may have an additional aggravating role. Pressure values within our reservoirs are comparable to those reported by others^{2,29} and lower than those reported by Steven and Poulsen²⁸. On the other hand, due to our strict use of 40 cm of ileum for the reservoir construction, we did

not have cases with huge reservoir capacity reaching more than 1000 cc as reported by Hautmann²⁹.

All our patients voided by Valsalva's technique with reasonable flow rates. The mean maximum flow rates of both the hemi-Kock and "W"-neobladders were above 15 ml/second with minimal residual urine. However, 13 patients showed significant residual urine volumes (≥ 150 ml), but the incidence was comparable in both groups of patients ($P=0.294$). Such residual urine volumes could be explained by a poor Valsalva's ability of the patient, kinking of the urethroileal junction or pouchocoele which compresses the urethroileal junction during straining. In a recent report, Steven and Poulsen found an increasing prevalence of large residual urine volume and need for intermittent catheterization with progress of time²⁸. Using a residual urine volume of 100 cc as a cut-off value, they reported the prevalence of the need of intermittent catheterization to be 44%. However, the choice of 100 cc as a cut-off value is questionable in reservoirs which have a capacity reaching up to 1000 cc. The results on the prevalence of residual urine in other studies are comparable to our findings in this selected group of patients^{2,9,29}. Furthermore, we did not find any correlation between residual urine volume and post-operative duration. When comparing their patients with satisfactory voiding against those with poor voiding (<15 ml/second), Mikuma and associates found two factors responsible for the poor voiding; the first one is a lack of positioning of the neobladder opening at the most caudal portion of the reservoir and the second is a loss of neobladder outlet elasticity with a lack of proper funnelling during voiding²⁷. Although large residual urine volumes are associated with a larger capacity ($R=0.46$) due to a progressive dilatation of the reservoir, yet, the resultant reduction of functional capacity and increased water shift by night will eventually cause nocturnal enuresis.

Asymptomatic bacteriuria was detected in nearly half of our patients in both groups without any statistically significant difference. Such high incidence in ileal reservoirs has been reported by several investigators³⁰⁻³². They attributed this high incidence to several factors including a poor drainage with subsequent residual urine, the use of staples or heavy sutures and/or excessive mucus production. However, this was not of clinical relevance as none of these patients experienced febrile

attacks or other manifestations of acute pyelonephritis. Urodynamically asymptomatic bacteriuria showed no correlation with any of the cystometric characteristics of both types of reservoirs. The commonest isolated organism was *E. Coli* followed by *Pseudomonas*, *Klebsiella* and *Proteus* in that order of frequency. The possibility of any chemical mediators released by such organisms or an inflammatory response to these organisms and their possible effect on smooth muscle behaviour of the reservoirs is to be further investigated.

We conclude that both types of reservoirs showed near optimum urodynamic characteristics with an excellent functional outcome thus confirming the results of previous studies. There are few differences regarding enterocystometric criteria which did not affect the functional outcome of the procedure. The relative preference of one procedure over the other will, therefore, depend on the surgeon's preference and the type of required anti-reflux technique.

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