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ORIGINAL PAPER

Voiding Symptoms and Urodynamic Findings in Patients with Modified Ileal Neobladde

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Abstract The aim of our study was to find the cause of urinary incontinence and voiding dysfunction in patients undergoing radical cystectomy and orthotopic bladder replacement with modified ileal neobladder (Reddy). Twenty-eight incontinent patients (operated on between 1988 and 2004) were involved in our examination. Based on the complaints of the patients, continence status was evaluated and divided into two groups: group I: partially incontinent (only night-time incontinence) $n=11$ (39.3%) and group II: totally incontinent (night-time and daytime incontinence) $n=17$ (60.7%). Detailed urodynamic examination (enterocystometry and urethral pressure profile) in addition to involuntary neobladder contractions and capacity detection were carried out on all patients. Furthermore resting pressure and maximal voluntary contraction ability of the sphincter were determined and statistically analyzed in both groups. Significant difference was noticed in resting pressure and maximal voluntary contraction ability of the sphincter among the partially incontinent and totally incontinent patients. Frequency, intensity and duration of involuntary neobladder contractions also showed significant differences between the two groups. Incontinence of neobladder depends not only on the destruction of resting and contraction capability of the urethral sphincter, but also on the presence or absence of involuntary contractions in the wall of the neobladder and decreased capacity of the neobladder.

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Introduction

The neobladder after radical cysto-prostatectomy could be formed by using both small and large bowels. Couvelaire [1], Lilien and Camey [2] were considered pioneers in performing orthotopic bladder replacement from the ileum; these trials were followed by many others afterwards [3–6]. The aim is to create the most perfect bladder that mostly meets the functions of the original urinary bladder. The most frequent complication reducing quality of life of patients is incontinence, mostly occurring at night. The incidence of daily incontinence is 0–65%, while the nocturnal incontinence is between 3%, 5% and 97% [4, 7–13]. The reasons of this significant fluctuation can be explained by different follow-up periods, different explanation of the term 'continence', and by the dissimilar type of orthotopic urine reservoir. Although there are countless publications focusing on incontinence after radical prostatectomy [14–16], much fewer studies are available on radical cystectomy. In addition, these manuscripts mainly concentrate only on questionnaire based patient surveys or on changes in the quality of life [7, 8, 17–24]. Only few examined urodynamical backgrounds of the post-cystectomy urinary incontinence (Table 1) [9–11, 13, 25–29]. Therefore, the aim of our examination was to determine the urodynamical cause of urinary incontinence and voiding disorders in patients undergoing radical cystectomy and orthotopic ileal bladder replacement (Reddy type) due to muscle invasive bladder cancer. We hypothesized that significant urodynamic differences occur between patients with complete and incomplete incontinence.

Table 1 Urodynamic differences in the neobladder

Reference	Year	The cause of incontinence
El-Bahnasawy MS [29]	2006	Ileal neobladder: neurovascular bundle resection (decreased maximum urethral pressure and shortened functional urethral length)
Burkhard FC [28]	2006	Ileal neobladder (Studer): missing urethrosphincteric guarding reflex: decrease of external urethral sphincter tonus
Jensen JB [13]	2006	Ileal neobladder (Hautmann): low capacity, high neobladder pressure
Laguna MP [11]	2005	Sigmoid neobladder (modified): decreased maximal urethral pressure, high neobladder pressure, low compliance
Schrier B [25]	2005	Ileal neobladder: periodical neobladder contractions and decrease of urethral sphincter tonus Sigmoid neobladder: low capacity of the neobladder
Skolarikos A [10]	2004	Ileal neobladder (modified): high pressure peristaltic waves override urethral resistance, decreased urethral sensitivity, decreased urethral pressure, relaxation of the pelvic floor.
Sevin G [26]	2004	Ileal neobladder: periodical neobladder contractions
Kulkarni J [9]	2003	Ileocecal neobladder: uninhibited bladder contraction or increase in reservoir pressure persistence of involuntary contractions Sigmoid: postvoid residual urine in neobladder
Reddy PK [4]	1991	Sigmoid neobladder (Reddy): low neobladder capacity, lack of filling sensation, spontaneous neobladder wall contractions

Materials and Methods

Total bladder replacement after cystoprostatectomy was carried out on 82 male patients (operated on between 1988–2004) using a detubularised segment of ileal to construct a urinary reservoir described first by Reddy [6] in 1987. The most important difference of this procedure from other orthotopic detubularised ileal neobladders is that a small part of the ileal segment remains tubular in order to form anastomosis to the urethra.

Twenty-eight incontinent patients (out of our 35) were involved in our study. Our total continence rate in male patients with Reddy type neobladder was 57.3% (47/82 patients). According to the International Continence Society criteria we considered patients incontinent in the case of any loss of urine or those who wore protective pads either daytime or night-time. The inclusion criteria were: urinary incontinence science the cystoprostatectomy, continent status before the surgery and the minimum 1 year follow up period. All patients had compensated acid-base balance parameters and had no tumours identified by CT examination. The patients were divided into two groups, group I: partially incontinent (daily continent, at night incontinent) $n=11$ (39.3%) and group II: totally incontinent (incontinent both at day and night) $n=17$ (60.7%).

The mean follow-up after cystectomy was 42.7±32.2 months (from 1 to 13 years). There was no significant difference concerning the time period between the day of surgery and our examination in the two groups. The mean age of patients involved in the study was 67.1±8.2 years. We did not notice significant differences in mean age in the two groups either. Similarly, there was no significant difference between the groups in body weight before the surgery and the loss of body weight postoperatively. Regarding the histological results no significant differences were found between the two totally and partially incontinent patients.

The analytical protocol consisted of the following steps:

1. Patients' history and evaluation of frequency/ volume charts
2. Physical examination and urinary stress test.
3. Exclusion of urinary infection.
4. Abdominal US to examine the upper urinary tract.
5. Uroflow examination was performed with Dantec 1000 equipment. The patients were asked to empty the neobladder at home usual bladder sensation (about at home generally voided urine volume). The patients voided in sitting position during Valsalva maneuver by relaxing sphincter. The post void residual urine was measured via a transurethral 14 Ch catheter.
6. Enterocystometry was carried out with Andromeda Ellipse 4 instrument using 8 Ch Medtronic microtip catheters. The pouch was filled up with room-temperature saline at a medium filling speed (50 ml/min). Reservoir sensation was registered. The neobladder was filled to the maximal enterocystometric capacity. The involuntary wall contractions of bowel bladder during the filling phase were also detected and if the contractions caused lower urinary tract symptoms, than it was defined as reservoir overactivity.
7. Pressure-flow examination after cystometry was carried out. Patients had to empty the bowel bladder in sitting position while the catheter was still inserted.

8. Urethral pressure profile measurements were performed to assess the resting closure pressure of the sphincter (P clos. max). Furthermore, maximal voluntary closure pressure of the sphincter (P sphinc. max) was measured during a voluntary pelvic floor contraction.
9. Urodynamic definitions were used in accordance with the instructions of International Continence Society [30].
10. Statistic analysis was performed by using one and two-pattern student *t*-test. The difference between the two samples was regarded statistically significant if it matched the criteria $p<0.05$.

Results

Uroflowmetry

All the patients voided in a sitting position using the Valsalva manoeuvre for ileal bladder emptying. This could be detected on the flow curve as periodical peaks. No significant differences were detected in maximal flow rate values and in postoperative residual urine between the groups. All of our patients in the study were able to empty the bladder completely without significant residual urine; therefore the patients did not perform self-catheterization. However, regarding voided volume (represented for usual at home voided urine volume) between the partially incontinent group and totally incontinent group significant differences were noted (Table 2).

Cystometry

The enterocystometric capacity was significantly higher in patients with partially incontinent than in the other group. In the filling phase during enterocystometry rhythmic, periodical bowel-wall contractions were noted. During the measurement 45.4% (5/11) of group I and 94.1% (16/17) of group II patients reacted with bowel contraction ($p<0.01$).

Table 2 Uroflow parameters

Uroflow parameters	Group I ($n=11$)	Group II ($n=17$)	p Value*
Max. flow rate (ml/s)	14±5.2	14.7±7	n.s.
Voided volume (ml)[a]	198.4±28.1	146.5±40.3	<0.001
PVR (ml)	7.37±14.9	14.1±9.4	n.s.

n.s. Not significant, *PVR* post void residual urine
[a] Represent for at home usual voided urine volume
*$p<0.05$

Regarding the neobladder overactvity, there was also a significant difference detected. The amplitude of the contraction was low in the partially incontinent patients. While it was significantly higher in the totally incontinent group. There was also a significant difference observed in the duration of contractions between the two groups respectively. The mean value of neobladder compliance was significantly less in group II than in group I (Table 3).

Figure 1 demonstrates a typical urodynamic curves of a totally incontinent patients with high frequency and high amplitudes neobladder contractions.

Urethral Pressure Profile

Significant differences were detected in the values of resting sphincter closure pressures as well as in the maximal voluntary contraction pressures of the sphincter between the partially incontinent and totally incontinent patients (Table 4).

Discussion

By creating a neobladder, the aim is to make a reservoir, which has ideal storage function and can be emptied with a low bladder pressure with a minimal residual urine. When the bladder is small it will not have abundant storage capacity; on the contrary, in case of a large neobladder the chance of retention will increase.

The capacity of the neobladder might increase postoperatively. Moreover, according to some experts, the final capacity of the neobladder can be determined one and a half years after the operation [31]. Based on our study, we did not detect the increase of bladder capacity over 1 year. The maximal bladder capacity (group I—401 ml, group II—292 ml on average) was achieved 6 months following surgery. Skolarikos [10] performed modified ileal neobladder for continent urinary diversion and evaluated functional results after 9 years of experience. They found an insignificant increase of enterocystometric capacity 391.6 and 440 ml, 6 months and 5 years after surgery respectively. Furthermore, there was an insignificant increase observed after a follow-up of 0.5–2 years; however after this period there was no increase detected. In the case of sigmoid neobladder, Laguna [11] detected a stabilized capacity of neobladder (about 300 ml) after a follow-up of 3 months to 5 years. In addition, Burkhard [28], who performed a urodynamic examination 9 months and 5 years separately after the surgery, could not detect increase in bladder capacity either. Drawing the conclusion, we have to note that the capacity of the neobladder (as one of the most important conditions of postoperative continence) is determined during surgery, therefore we cannot expect a significant increase in capacity

Table 3 Enterocystometry findings and comparison of parameters

Enterocystometry findings	Group I, (n=11: 100%)	Group II, (n=17: 100%)	p Value*
The capacity of the neobladder (ml)	401±57	292±60	<0.001
The number of patients having pouch contractions n (%)	5 (45.4)	16 (94.1)	<0.01
The number of patients having pouch overactivity[a] n (%)	3 (27.3)	10 (58.8)	<0.01
The pressure values[b] of contractions (cmH_2O)	3.1±1.9	17.4±10.3	<0.0001
The duration of contractions (s)[c]	2.8±1,6	11±5.6	<0.0001
Compliance (ml/cmH_2O)	22.9±5.4	15.4±3.4	<0.001

[a] Patients having pouch contractions and frequency, urgency symptoms
[b] The rate of high pressure (>10 cmH2O) contractions: 5/11 vs 16/17 (group I vs II)
[c] The rate of longer time (>10 s) contractions: 5/11 vs 16/17 (group I vs II)
*p<0.05

postoperatively. Hence we do have to place a demand on the type and length of the resected bowel segment.

Urinary retention and urinary incontinence are the two most frequent complications in patients with neobladder. Urine voiding in an ileum bladder is managed by a passive mechanism with a Valsava manoeuvre (including relaxation of urinary sphincter) in a sitting position in male patients which results in a lacerated uroflow curve. By applying Hautmann ileal neobladder or sigmoid neobladder, more than 100 ml residual urine and the necessity of clean intermittent self-catheterisation can be observed in some patients [9, 10, 12, 19]. Jensen [13] (in cases of Hautmann bladder) used intermittent self catheterization (CIC) with 57% of his patients. Kulkarni [9] noted the necessity of CIC in the case of sigmoid bladder in 59%. On the contrary, in our study there was no clinically significant retention measured either in group I or group II and so there was no need for self-catheterization. A possible explanation for this finding might be that when performing a Reddy bladder, the resected ileum compartment is cut and detubularised except for a 5 cm long slice on the central bowel compartment which is left intact as the place of the urethral stump anastomosis [6]. Therefore, this untouched and most caudal part of the bowel bladder restores its peristaltic motility that later provides for retention-free voiding and also minimizes the risk of kinking and obstruction at the anastomotic site [20, 25]. However, if the capacity of the neobladder is low (group II), the patients more easily become incontinent because of the intact 5 cm long bowel segment. Reddy [6] mentions only two cases in his study. Observing the literature, we have to note that our present study seems to be the most detailed one focusing on the function results of Reddy type ileal neobladder.

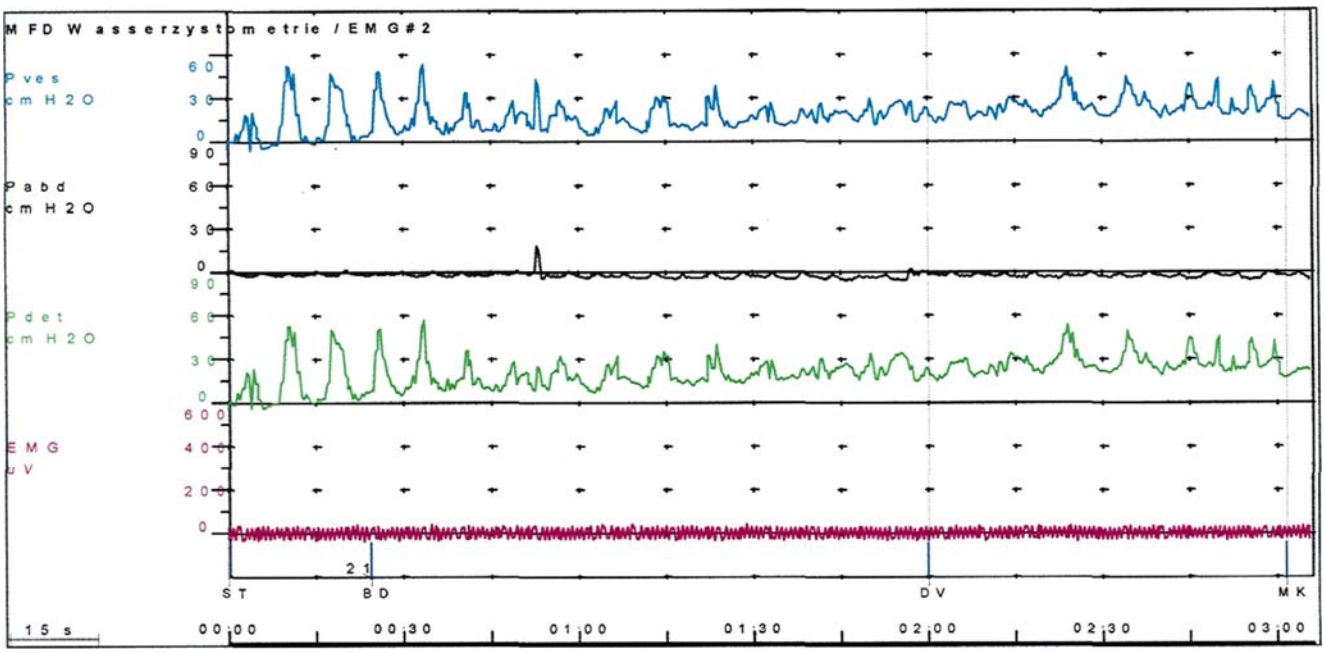

Fig. 1 High frequency bowel contractions in a totally incontinent patient

Table 4 Urethral pressure profile (UPP) parameters

UPP parameters	Group I (n=11)	Group II (n=17)	p Value*
P. clos. max (cmH_2O)	45.7±5.7	22.1±8.9	<0.001
P. sphinc. max (cmH_2O)	102.2±26.7	52.7±28.1	<0.001

P. clos. max Resting urethral sphincter closure pressure, *P. sphinc. max*. maximal voluntary sphincter closure pressure
*p<0.05

The other frequent complication, which probably mostly influences the patient's quality of life is urinary incontinence. 47/82 of our patients were totally continent (57.3%), 13 (15.8%) were incontinent night-time, 22 patients (26.8%) complained about both night-time and daytime incontinence. Although these data seem to be worse than the ones published recently (73–97.5%) [10, 12, 13]. We have to emphasize that in our study continence status is taken very seriously (patients who are continent daytime as well as at night and wearing no protective pads). There are only few authors using similar continence definition, however, the results they get can be related to their own materials [13, 29]. The cause of weaker continence results could also be traced in our elderly patients. In our study the mean age of patients was 67.1 years, whereas in the studies reaching better continence status the mean age was 56–62 [10, 12, 13]. The causes of incontinence in an ileal neobladder have to take both the functions of the bladder and the functions of sphincter into consideration. Involuntary bowel wall contractions can occur in all neobladder. Jakobsen [32] described muscular contractions as a primary reason of urinary incontinence in non-detubularised ileocoecal neobladder. Moreover, this growth in the bowel bladder causes incontinence mainly at night since there was an increased volume of urine stored in the bladder, while the patients were sleeping and the voluntary sphincter closure function did not work. Based on the literature, it is well known that in case of ileal or sigmoid colon neobladders the contraction ability usually persists [11, 12] and the size and periodicity play an important role in nocturnal incontinence. According to Jakobsen's grading, we can divide the contractions into two groups: high-pressure contraction (above 10 H_2Ocm) and low-pressure contraction (under 10 H_2Ocm) [32]. In our study we found differences regarding the characteristic of neobladder contractions between the partially and a total incontinent patients.

Amplitudes of muscular contractions as well as their duration were significantly different between group I and group II. Based on our results it seems that the patients with long duration and high amplitude contractions have an increased risk of developing total urinary incontinence. The rate of patients having ileal bladder contractions was 45.4% in group I while more significant contractions were observed in group II (94.1%). This high rate of contraction can be interpreted with the intact medium part of a Reddy type ileal bladder. Therefore, the movement appearing in Reddy type ileal bladders might come either from the 5 cm long intact bowel segment or muscular movements of the detubularised ileal wall. High amplitude contractions can explain urge complaints of patients as well as incontinent periods. According to their duration, two different kinds of contractions were observed during urodynamic examination. Patients having short contractions did not have any complaints, on the contrary, in patients with long contractions incontinence was observed. Yadav [12] found that in the case of Reddy type sigma neobladder the number of bowel contractions thus the incontinent episodes could be increased if the isoperistaltic distal bowel segment is also detubularised. However, unlike in our study, he observed significant urine retention more often in this case. In order to maintain continence we tried to perform atraumatic preparation of the spinchter regio. Closure function depends on resting urethral sphincter tone and maximal voluntary sphincteric contraction. Both depend on cerebral control. In case of general nocturnal muscular hypotonia, the activity of the urethral sphincter is decreased as well. In our study we founded, the resting urethral sphincter tone of 45 H_2Ocm was sufficient to maintain daily continence, it was insufficient to maintain nocturnal continence due to a general decrease of muscular tone during sleep. Besides its resting urethral sphincter tone, the contraction ability of the sphincter is very important as well.

During the sphincter pressure examination after forming the ileal neobladder, Porru [33] detected incontinence under 45 H_2Ocm sphincter tonus. Although he involved only 12 patients in his study, this result is similar to our results. Based on Tanao's [34] study, we know that in a normal urinary tract there is an increased closure pressure mechanism to progressive bladder filling. Following cystectomy the afferent stem of the reflex is missing, therefore there is no increase of closure pressure in the case of progressive bladder filling. According to Skinner [35], this might be the explanation for the increased number of incontinence after neobladder replacement compared to incontinence status after radical prostatectomy. We have found that if this value does not exceed about the double value of the resting tone, we will have to expect incontinence in stressful situations or in the case of high frequency bowel contractions. We detected that the mean value of muscle contraction to maintain daily continence is 102 H_2Ocm, which meets the data published in the literature [13, 14]. Finally, we have to conclude that in the case of orthotopic ileum neobladder replacement the causes of incontinence could be traced in decreased urethral sphincter pressure, long bladder wall contractions with high amplitudes and the insufficient bladder volume.

Furthermore, we found that isoperistaltic detubularised bowel segment applied at forming Reddy type ileal bladder—despite the fact that it increases involuntary contractions—will help voiding and will not increase incontinence if the bladder bears sufficient capacity.

Conclusions

Based on our results we can assume that the most important parameters of continence after radical cystectomy with neobladder are the sufficient rest and voluntary urethral sphincter pressure, the minimum 400 ml neobladder capacity and the absence of neobladder hyperactivity. It seems that the undetubularised bowel segment in case of the Reddy ileal bladder has an important role in emptying the neobladder without retention.

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