Urinary and Fecal Diversion Following Pelvic Exenteration: Comparison of Double-Barrelled and Plain Wet Colostomy

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Purpose: To assess early and late-term outcomes of patients who had undergone pelvic exenteration and simultaneous fecal and urinary diversion with plain wet colostomy (PWC) or double-barrelled wet colostomy (DBWC).

Materials and Methods: The medical records of all patients who had undergone pelvic exenteration and urinary diversion between 2006 and 2017 at our hospital were reviewed retrospectively.

Results: In total, 15 patients with a mean age of 56 ± 13 years were included in the study. Simultaneous urinary and fecal diversions were carried out as PWC (n = 8), or DBWC (n = 7). No significant differences were found between PWC and DBWC groups in terms of operation time (373.7 ± 66.5 versus 394.2 ± 133.2 min, P = .955), estimated blood loss (862.8 ± 462.4 versus 726.2 ± 489.4 mL, P = .613), length of hospital stay (13.2 ± 9.1 versus 14.1 ± 6.9 days), early complications (25% versus 28.6%, P = 1.0) and late term complications (37.5% versus 42.9%, P = 1.0). The rate of recurrent pyelonephritis in PWC group was higher than DBWC group but not statistically significant (37.5% versus 14.3%, P = .569). Overall survival (OS) of the patients was 385 ± 91 days. There was no difference between OS of patients with PWC and DBWC (414 ± 165 versus 352 ± 70 days, P = .618).

Conclusion: PWC and DBWC are valid options for creating simultaneous urinary and fecal diversion after extensive pelvic surgery in patients with short life expectancy. DBWC might be superior to PWC in terms of decreased risk of recurrent pyelonephritis.

Keywords: pelvic exenteration; wet colostomy; double-barreled; urinary diversion

INTRODUCTION

Due to recent advancements in anesthesiology, surgical techniques and surgical tools, surgeons are able to perform more complicated, risky and long-lasting operations. “Pelvic exenteration” is one of these complex procedures that is commonly used in the treatment of locally advanced pelvic tumors, organ injury secondary to radiotherapy, and benign but locally destructive pathologies.

Pelvic exenteration was first described by Alexander Brunschwig in 1948[(1)] in the treatment of pelvic tumors. Besides rectosigmoid colon, pelvic peritoneum, draining lymph nodes, reproductive organs, urinary bladder and distal ureters are also excised necessitating reconstructions for urinary and intestinal diversions in these procedures.

To date many researchers developed different techniques to store urine in pressures safe for upper urinary tract without causing an electrolyte imbalance[(1-4)]. However, in addition to aforementioned principles, operation time, postoperative course/complications and patient quality of life (QoL) must be considered.

In this study, we aimed to report the outcomes of patients who had undergone simultaneous fecal and urinary diversion after pelvic exenteration, comparing plain wet colostomy (PWC) with double-barrelled wet colostomy (DBWC) technique. To our knowledge, this is the first retrospective study that compares PWC with DBWC.

PATIENTS AND METHODS

Study Population

The medical records of all patients who had undergone pelvic exenteration and urinary diversion for primary or recurrent pelvic malignancies at the Hacettepe University Hospital between 2006 and 2017 were reviewed retrospectively. The surgeries were performed under the collaboration of General Surgery and Urology Departments.

Surgical Technique

All patients had undergone abdominoperineal resection (APR), which included resection of rectum, anus, urinary bladder, and pelvic lymph nodes accompanied by total prostatectomy in male patients and total abdominal hysterectomy, bilateral salpingo-oopherectomy, and total vaginectomy in female patients. In 8 patients, fecal and urinary diversions were carried out with plain wet colostomy (PWC), while 7 patients had undergone double-barrelled wet colostomy (DBWC). The choice of urinary diversion was based on perioperative decision of general surgeon and urologist, depending on the length of the mesocolon. If the mesocolon was long enough DBWC was preferred.

DBWC was constructed as described previously by

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Table 1. Patients Demographics, Characteristics, Intraoperative/Postoperative Features and Follow-up

No	Sex	Age	Primary Pathology	Prior Surgery	Prior Radiotherapy	Operation	Type of Diversion	Early Complication	Late term complication	Electrolyte imbalance	Overall survival (days)	Exitus-Alive
1.	F	48	Cervix Ca	TAH+ BSO	Yes	APR+ cystectomy	PWC	Intraabdominal abscess	No	No	7	Ex
2.	F	42	Cervix Ca	None	Yes	APR+ cystectomy+ TAH + BSO	PWC	Ureterocolonic Leakage	No	No	87	Ex
3.	F	70	Colon Ca	None	No	APR+ cystectomy+ TAH + BSO	PWC	No	No	No	859	Ex
4.	M	51	Rectum Ca	Anterior Resection	Yes	APR + CP+ sacrectomy	PWC	No	Pyelonephritis	No	418	Ex
5.	M	59	Rectum Ca	Anterior Resection	Yes	APR + CP	PWC	No	Pyelonephritis	No	503	Ex
6.	M	55	Prostate Ca	None	Yes	APR + CP	PWC	No	No	No	43	Ex
7.	M	65	Rectum Ca	Anterior Resection	Yes	APR + CP	PWC	No	No	No	89	Ex
8.	M	45	Rectum Ca	Anterior Resection	Yes	APR + CP	PWC*	No	Pyelonephritis	No	1313	Ex
9.	M	68	Rectum Ca	Anterior Resection	Yes	APR + CP	DBWC	No	Pyelonephritis	No	628	Ex
10.	M	49	Colon Ca	Right hemi colectomy	No	APR + CP	DBWC	No	No	No	454	Ex
11.	M	79	Rectum Ca+ Prostate Ca	None	Yes	APR + CP	DBWC	Right Pneumothorax	No	No	260	Ex
12.	M	55	Colon+ rectum Ca	None	No	APR + CP	DBWC	No	Hydronephrosis	No	496	Ex
13.	M	57	Colon Ca	Colostomy	No	APR + CP + sacrectomy	DBWC	No	Sacral abscess	No	329	Ex
14.	M	70	Prostate Ca	None	Yes	APR + CP	DBWC	Ileus	No	No	222	Ex
15.	F	28	Rectum Ca	Anterior Resection	Yes	APR + cystectomy + TAH + BSO	DBWC	No	No	No	78	Ex

Abbreviations: APR, Abdominoperineal resection; TAH, Total abdominal hysterectomy; BSO, Bilateral salphingo-oopherectomy; IL, Ileal loop; CP, Cystoprostatectomy; PWC, Plain Wet Colostomy; DBWC, Double-barrelled wet colostomy; F, Female; M, Male; Ca, Cancer; Ex, Exitus
*Converted to colostomy plus ileal loop

Carter et al[5]. Rectosigmoid or descending colon was used for loop colostomy depending on the level of colectomy. Splenic flexure was mobilized to ensure a tension free position for the loop colostomy and the loop was constructed before the anastomosis of ureters to prevent twisting. The ureters were mobilized as much length as possible while taking care to preserve the periureteral vascular supply. The opposite sided ureter was then transposed to the loop colostomy side through a tunnel at mesocolon.

Each ureter was implanted individually into the distal, blind-ended limb of the loop colostomy. For prevention of reflux, ureters were anastomosed at the antimesenteric region with 3-4 cm long submucosal tunnels[5, 6]. A mammary implant was placed in the pelvic cavity in 9 cases to prevent prolapsus of intestines. To preserve the anastomosis, ureteral stents were placed bilaterally, fixed to colonic mucosa with absorbable sutures and removed after 3 weeks. The loop was exteriorized and fixed to the abdominal wall as double-barreled following the implantation of the ureters. The distal blind-ended part of the loop acts as a reservoir for urine to minimize contact of urine and feces in patients with DBWC [5,7-9]. In case of plain wet colostomy, ureters were anastomosed to colostomy forming an ureterocolostomy.

Outcome Assessment

The examined parameters consisted of patient demographics, primary pathology, type of surgery, operation characteristics, and post-operative follow-up including blood chemistry and imaging results. Complications such as pyelonephritis, urinary leak and fistulas, hydronephrosis and metabolic disturbances were also compared between the two groups. Renal functions of the patients were followed by plasma creatinine (Cr), blood urea nitrogen (BUN) and electrolytes. If the patient's clinical findings indicated urinary tract infection, urine analysis and culture were performed. The primary disease, surgical outcome and urinary system were examined by abdominopelvic imaging [ultrasonography (USG), computed tomography (CT), or magnetic resonance imaging (MRI)] at necessary periods.

All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS, version 21.0, IBM, Chicago, IL, USA). Mean ± SD and range were used to express quantitative values, and number and percentage were given for qualitative values. Chi-square test, Fisher's exact test, Mann-Whitney U test and Student's t test were applied to compare the two groups. Kaplan-Meier analysis was used for survival analysis. *P* values <0.05 were considered as statistically significant.

RESULTS

In total, 15 patients whom all data was available were included in the study. Characteristics of patients are summarized in **Table 1**. Mean age of the patients was 56 ± 13 years, ranging from 28 to 79. In all patients, urinary system was affected by the primary pathology. Eleven patients had previously received pelvic radiotherapy and 9 patients had undergone previous surgical procedures. Mean operation time was 383 minutes (range 240 - 570). Mean hospitalization time after surgery was 13.6 ± 7.8 days.

Preoperative and postoperative mean Cr level were 1,02 ± 0.32 mg/dL and 1,18 ± 0.52 mg/dL, respectively. Only one patient's Cr level was above the normal, whose level was also abnormal preoperatively. No metabolic disturbances were encountered related with colonic/urinary conduit. Mean postoperative serum Na and K+ levels were 136.1 ± 4.7 mg/dL and 4.1 ± 0.43 mg/dL, respectively.

At early postoperative period (within one month after the surgery), one ureterocolonic anastomosis leakage and one intraabdominal abscess in the PWC group; one unilateral pneumothorax and one ileus in the DBWC group were observed. Nephrostomy catheter was inserted to the kidney of the patient due to anastomosis leakage and the catheter was removed after demonstration of no leakage at 2nd month on anterograde pyelography with minimal hydronephrosis in USG.

Late-term (30 days or more after the surgery) complications were observed in 6 patients including 3 pyelonephritis and 1 sacral abscess, which were managed by antibiotic treatment. In one patient with recurrent pyelonephritis, PWC was converted to ileal conduit for urinary diversion. In one patient with DBWC, unilateral grade 2-3 hydronephrosis caused by ureterocolonic stenosis was managed with percutaneous nephrostomy initially, which was replaced by indwelling stent subsequently. Pyelonephritis was observed only in one patient in the DBWC that was managed conservatively with antibiotics. One of the patients in the PWC group died 7 days after the surgery in the early postoperative period. She had multiple metastases due to cervix cancer and postoperatively experienced pulmonary thromboembolism which was treated with low molecular weight heparin.

Comparison of patient outcomes of DBWC and PWC are summarized in **Table 2**. No significant differences were found between the two groups in terms of age, operation time, estimated blood loss, length of hospital stay, early- and late-term complications (All *p*-values > .05). The rate of recurrent pyelonephritis in PWC group was higher than DBWC group but not statistically significant (37.5% versus 14.3%, *P* = .569).

Overall survival (OS) of the patients was 385 ± 91 days. There was no difference between OS of patients with PWC and DBWC (414 ± 165 versus 352 ± 70 days, *P* = .618).

DISCUSSION

Pelvic exenteration is the standard choice of treatment for advanced or recurrent pelvic malignancies, which involves removal of all pelvic viscera. Besides being an extensive surgery, it also requires reconstruction for urinary and fecal diversions[10]. In the first series of pelvic exenteration, urinary diversion was carried out by anastomosing each ureter to ipsilateral colon segment and opening a terminal colostomy after the reconstruction stage, which was called as "proximal wet colostomy" [1,2]. However, high volume watery diarrhea, severe electrolyte imbalance and pyelonephritis resulting in poor life quality led the surgeons to investigate new diversion types. Besides, mixing up of urine and feces on intestinal surfaces was accused for the intestinal dysplasia and neoplasia diagnosed in long term follow up[2, 3,11]. Due to the lack of an optimum type of diversion, Bricker et al. in 1949[4] described ileal segment to discard urine via a different way from feces, decreasing diarrhea and dysplasia. However, as majority of these patients had received radiotherapy, leakage from anastomosis was a major concern. Also, the presence of two stomas not only resulted in prolonged operation time but also negatively influenced patient's quality of life. In 1989, Carter et al. first defined 'Double-barrelled wet colostomy' (DBWC) which is the lateral loop colostomy that contains both urinary and intestinal diversions in the same segment and drains from a single stoma[5]. It is a simple, safe and effective procedure to reconstruct urinary and fecal drainage after pelvic exenterations where orthotopic urinary or intestinal reconstructions are not possible[7-9,12-15]. Besides, using the distal colon for loop colostomy enables formation of feces proximally and prevents loss of excess fluid.

In our patient cohort, we preferred PWC or DBWC for urinary and fecal diversion following pelvic exenteration depending on the length of mesocolon. To our knowledge, this is the first retrospective study that compares PWC with DBWC. Previously published articles usually focused on comparison of DBWC with ileal conduit plus colostomy. DBWC enables single stoma and shorter operation time compared to two stomas technique and also preserves intestinal integrity that prevents intestine related complications i.e. pouch leak and enteric fistulas[5,7-10,12-15]. In some studies, DBWC has also been found to be superior to two stomas technique in terms of hospital stay, pyelonephritis, sepsis, electrolyte imbalance, urinary leak and need of percu-

Table 2. Comparison of Patients' Characteristics and Outcomes of DBWC and PWC Procedures.

Groups	PWC (n=8)	DBWC (n=7)	*P* value
Age (year)	54.3 ± 9.7	58 ± 16.7	0.463
Operation time (minutes)	373.7 ± 66.5	394.2 ± 133.2	0.955
Estimated blood loss (ml)	862.8 ± 462.4	726.2 ± 489.4	0.613
Length of stay (days)	13.2 ± 9.1	14.1 ± 6.9	0.613
Pyelonephritis	37.5%	14.3%	0.569
Early-term complication (%)	25%	28.6%	1.000
Late-term complication (%)	37.5%	42.9%	1.000
Overall Survival (days)	414 ± 165	352 ± 70	0.618

taneous nephrostomy. However, none of these studies showed the superiority of ileal conduit with colostomy in any evaluated parameters[10].

Complications related to wet colostomy following the first series of pelvic exenteration were usually associated with ascending urinary tract infections from reflux of intestinal contents, severe electrolyte imbalance, obstruction at the uretero-intestinal anastomosis resulting in progressive hydronephrosis and impaired renal function and development of fistulas from the anastomosis site[16].

In a study focusing on urological complications after cystectomy, the urological complication rates was significantly higher after cystectomy as a part of pelvic exenteration (59%) compared to cystectomy alone (33%). Urinary leak was observed in 6% and 14% of the patients who underwent pelvic exenteration for primary malignancies and recurrent malignancies, respectively. Major blood loss and previous pelvic radiotherapy was found to be an independent predictor of conduit-associated complications[17]. In our series most of the patients (9/14) underwent pelvic exenteration for recurrence.

In another study comparing ileal versus colonic conduit after pelvic exenteration, colonic conduit was found to be associated with fewer complications (including sepsis, leak and pelvic collection) compared to ileal conduit (19% versus 40%, $p < 0.01$)[18]. In our patient cohort, two complications (13.3%) (one leak and one intraabdominal abcess) were observed in concordance with aforementioned study.

Despite these severe complications reported previously, we have not encountered any severe electrolyte disturbance in our PWC serial. In the present study, three patients (37.5%) with PWC experienced recurrent pyelonephritis. Two patients were treated with antibiotic therapy and in the other patient urinary diversion was converted to ileal loop. Among patients with DBWC, only one patient (14.3%) experienced pyelonephritis. Although, it was not statistically significant ($P = .569$), we found DBWC superior to PWC in terms of upper urinary tract infection. Furthermore, none of the patients required re-operation during the early postoperative period.

As described in previous studies[1,19], preserving periureteral vascular supply while mobilizing and preparing the ureter is of critical importance to avoid necrosis leading strictures and anastomotic leaks. At our institution, we are firmly committed to this principle and in our patient cohort, only one patient (6.6%) developed ureterocolonic leakage.

In our series, not only patients with DBWC but also patients with PWC did not develop any secondary neoplasia due to mixing of urine and feces. We think this might be related to short survival period of our patients. The filling of pelvic cavity with intestinal loops following pelvic exenteration can result in increased risk of complications such as intestinal obstruction, enteric fistulas and radiation enteritis especially in patients undergoing postoperative radiotherapy. To avoid this complication, we placed mammary implants in the pelvic cavity of 9 patients, as described previously[20]. No complications were observed related to the prosthetic implants in our series.

This study has also some limitations. First of all, our sample size was relatively small and it was not possible to compare the quality of life between patients with different type of diversions because of the retrospective nature of the study. And the exact operation time of creating a diversion was not available in this study. So, it is difficult to determine the effect of type or urinary diversion on operation time.

CONCLUSIONS

Plain wet colostomy (PWC) and double barrelled-wet colostomy (DBWC) are valid options for creating urinary diversion after extensive pelvic surgery. DBWC might be superior to wet colostomy in terms of decreased risk of recurrent pyelonephritis. PWC could be the choice of urinary diversion especially in patients with short life expectancy to avoid intestinal neoplasia and dysplasia.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. Brunschwig A. Complete excision of pelvic viscera for advanced carcinoma; a one-stage abdominoperineal operation with end colostomy and bilateral ureteral implantation into the colon above the colostomy. Cancer. 1948;1:177-83.
2. Brunschwig A, Daniel W. Pelvic exenteration operations: with summary of sixty-six cases surviving more than five years. Ann Surg. 1960;151:571-6.
3. Wear JB, Jr., Barquin OP. Ureterosigmoidostomy. Long-term results. Urology. 1973;1:192-200.
4. Bricker EM. Bladder substitution after pelvic evisceration. Surg Clin North Am. 1950;30:1511-21.
5. Carter MF, Dalton DP, Garnett JE. Simultaneous diversion of the urinary and fecal streams utilizing a single abdominal stoma: the double-barreled wet colostomy. J Urol. 1989;141:1189-91.
6. Kristjansson A, Mansson W. Refluxing or nonrefluxing ureteric anastomosis. BJU Int. 1999;84:905-10.
7. Carter MF, Dalton DP, Garnett JE. The double-barreled wet colostomy: long-term experience with the first 11 patients. J Urol. 1994;152(6 Pt 2):2312-5.
8. Guimaraes GC, Ferreira FO, Rossi BM, et al. Double-barreled wet colostomy is a safe option for simultaneous urinary and fecal diversion. Analysis of 56 procedures from a single institution. J Surg Oncol. 2006;93:206-11.
9. Kecmanovic DM, Pavlov MJ, Ceranic MS, Masulovic DM, Popov IP, Micev MT. Double-barreled wet colostomy: urinary and fecal diversion. J Urol. 2008;180:201-4; discussion 4-5.
10. Gan J, Hamid R. Literature Review: Double-Barrelled Wet Colostomy (One Stoma) versus

Ileal Conduit with Colostomy (Two Stomas). Urol Int. 2017;98:249-54.

11. Urdaneta LF, Duffell D, Creevy CD, Aust JB. Late development of primary carcinoma of the colon following ureterosigmoidostomy: report of three cases and literature review. Ann Surg. 1966;164:503-13.
12. Osorio Gullon A, de Oca J, Lopez Costea MA, et al. Double-barreled wet colostomy: a safe and simple method after pelvic exenteration. Int J Colorectal Dis. 1997;12:37-41.
13. Blanco Diez A, Fernandez Rosado E, Alvarez Castelo L, et al. [Double-barreled wet colostomy: analysis of a urinary diversion]. Actas Urol Esp. 2003;27:611-7.
14. Takada H, Yoshioka K, Boku T, et al. Double-barreled wet colostomy. A simple method of urinary diversion for patients undergoing pelvic exenteration. Dis Colon Rectum. 1995;38:1325-6.
15. Lopes de Queiroz F, Barbosa-Silva T, Pyramo Costa LM, et al. Double-barrelled wet colostomy with simultaneous urinary and faecal diversion: results in 9 patients and review of the literature. Colorectal Dis. 2006;8:353-9.
16. Teicher I, Karlitz LM, Shaftan GW. Complications of a wet colostomy after pelvic evisceration corrected by separation of urinary and fecal streams; report of a case. Ann Surg. 1953;137:129-34.
17. Brown KG, Solomon MJ, Latif ER, et al. Urological complications after cystectomy as part of pelvic exenteration are higher than that after cystectomy for primary bladder malignancy. J Surg Oncol. 2017;115:307-11.
18. Teixeira SC, Ferenschild FT, Solomon MJ, et al. Urological leaks after pelvic exenterations comparing formation of colonic and ileal conduits. Eur J Surg Oncol. 2012;38:361-6.
19. Chokshi RJ, Kuhrt MP, Schmidt C, et al. Single institution experience comparing double-barreled wet colostomy to ileal conduit for urinary and fecal diversion. Urology. 2011;78:856-62.
20. Valle M, Federici O, Ialongo P, Graziano F, Garofalo A. Prevention of complications following pelvic exenteration with the use of mammary implants in the pelvic cavity: Technique and results of 28 cases. J Surg Oncol. 2011;103:34-8.