Original Research Article

A single centre 10-year experience of Mitrofanoffs procedure for varied indications with its outcome

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ABSTRACT

Background: To evaluate long term efficacy and complications of Mitrofanoffs procedure in patients with bladder dysfunction.

Methods: Authors retrospectively reviewed the medical records of 51 patients who underwent construction of a continent catheterisable channel (mitrofanoffs and monti) from 2009 till 2019 in our institution. Clinical findings and investigations result along with surgical techniques used were noted for these patients. Postoperative complications along with urinary continence and renal outcome were evaluated.

Results: Mean age was 7 years and mean follow up was for 3 years. 27 patients were with neurogenic bladder and 24 with non-neurogenic bladder. The most common type of conduit was appendicovesicostomy (38) followed by ileal monti (12) and ureter (1). The most common stomal site was umbilicus (44) followed by right lower abdominal quadrant (6). Catheterizable conduit complications included stomal leakage in 3, mucosal prolapse at the stoma site in 1 and an intra peritoneal leak requiring exploratory laprotomy and revision in 1. Relative stomal continence was achieved in 98%. The preoperative serum creatinine & blood urea nitrogen (BUN) at the time of mitrofanoffs procedure at the last follow up after the procedure were sought and compared using Chi square test showed statistically significant improvement ($p < 0.01$). No differences in outcome and complication rates were noted between different types of conduit, sites of implantation, or segments used for augmentation.

Conclusions: Mitrofanoff is a safe and reliable procedure in children who are dependent on intermittent catheterisation in developing countries. Appendicovesicostomy is our first option followed by yang -monti illeovesicostomy. While stomal continence is excellent patient education, family motivation and cost reduction are important factors for its lasting efficiency.

Keywords: Continence, Developing countries, Mitrofanoffs procedure, Neurogenic bladder, Yang -monti illeovesicostomy

INTRODUCTION

Paul Mitrofanoff described the 'trans-appendicular continent cystostomy' in 1980, as an alternative route for catheterizing the bladder when the urethra could not be used.¹ Appendicovesicostomy has traditionally represented an ideal conduit followed by, the transverse ileal (YangeMonti) tube. Series reporting 10 year follow

up are rare in developing countries. In the developed world, Clean intermittent catheterization (CIC) entails support from the community nurses and the use of disposable catheters, these factors are not economical and feasible in developing countries. In this study authors test the long-term efficacy and record the complication rate along with final continence outcome and preservation or improvement in renal function along with modifications

required for cost reductions in children undergoing mitrofanoffs procedure.

METHODS

Authors retrospectively collected data from the medical records of all children of this institute who underwent continent catheterisable channel (CCC) creation between 2009 and 2019, regardless of indication. Authors included children who had undergone either appendicovesicostomy (Mitrofanoff channel) or creation of a CCC with reconfigured bowel (Monti 13) or using other structures such as the ureter. Patients were excluded from the study if they underwent laparoscopic or laparoscopic assisted surgeries.

Demographic data, underlying etiology, associated concurrent procedures and type of surgical revision were also collected. Other variables such as conduit type (Mitrofanoff or Monti) and site of stoma (skin anastomoses to umbilicus or lower quadrant), status of the channel, no of surgical revisions were analysed up to last follow up. The preoperative investigations included renal function test (serum creatinine and blood urea nitrogen), micturating cystogram for bladder capacity and leak point pressure, renal ultrasonography and radionuclide nephrography (DTPA scan) for upper tract status were noted. Medical management with anticholinergics was started in indicated patients and clean intermittent catheterisation was implemented preoperatively in all patients.

Operative technique

Following abdominal exploration and preparation of bladder for augmentation if necessary, the appendix is mobilized, preserving its blood supply. The appendix is isolated on its mesentery and disconnected from the caecum, then catheterized with a 10-F catheter to ensure patency. A submucosal tunnel of 3-4cm length is created in the bladder or intestinal segment and the appendix is implanted. The bladder wall is fixed to the anterior abdominal wall at the point of entry of Mitrofanoff channel into the bladder, so as to ensure a straight course of conduit. It is important to check for smooth catheterization throughout this process. The anastomosis of conduit to the skin is performed to the umbilicus or abdominal wall using the V-flap technique or the VQZ technique.

In patients where the appendix was unsuitable or used to access the colon via the antegrade colonic enema (ACE) procedure, ileum was used by Monti's principle. In it a 2.0-2.5 cm segment of ileum was detubularized in the para-mesenteric border resulting in a tube of 6-7 cm in length, when transversely retubularized (Figure 1 and 2).

Postoperatively patients were followed up with renal function test; ultrasonography and DTPA scan to see for the renal status. While serum creatinine and blood urea

nitrogen (BUN) estimations have been made on many occasions both preoperatively and postoperatively, 2 critical values were sought for each child; the preoperative serum creatinine and BUN at the time of mitrofanoff procedure (termed creatinine -1 and BUN -1) and the serum creatinine and BUN at the last follow up after mitrofanoff procedure (termed creatinine -2 and BUN- 2) and was analysed using the chi square test. Social continence and dry interval period between clean intermittent self-catheterizations were noted.

Figure 1: Preparation of ileal monti tube.

Figure 2: Ileal monti to use as mitrofanoffs in an augmented bladder.

RESULTS

During the period from 2009 to 2019, 51 patients in our institution underwent mitrofanoffs procedure. Out of 51 patients, 26 were male and 25 were female. The mean age at surgery was 7 year (4 year - 16 years) with a mean follow was 3 year (1year to 10 years).

Majority of patients belonged to middle or lower socioeconomic background. The primary etiology of bladder dysfunction is represented in Table 1.

Table 1: Primary etiology of bladder dysfunction.

Etiology of bladder dysfunction	No. of patients
Neurogenic bladder	27
Meningomyocele	9
Anorectal malformation with vertebral anomalies	11
Nonneurogenic neurogenic bladder	1
Partial sacral agnesis	6
Non neurogenic bladder	24
Extrophy epispadias complex	14
Posterior urethral valves	6
Anterior urethral valve	1
Bilateral ectopic ureter	2
Stricture urethra	1

Thirty patients out of 51 underwent augmentation cystoplasty (AC) in conjunction with mitrofanoffs procedure, using ileum (17), caecum (9) and sigmoid (4). 5 patients underwent penns pouch reconstruction, 13 patients underwent bladder neck disconnection; 3 patients underwent tightening of the bladder neck using the rectus sling, 13 patients with preoperative vesicoureteric reflux and history of multiple urinary tract infections underwent ureter reimplantation along with augmentation. In 10 patients with fecal incontinence Malone antegrade colonic enema (MACE) stoma was constructed. These combined procedures along with mitrofanoffs procedure are summarized in Table 2.

Table 2: Combined procedures along with Mitrofanoffs procedure.

Procedures	No. of patients
Augmentation cystoplasty	30
Penns pouch	5
Bladder neck disconnection	13
Rectus sling of bladder neck	3
ureteric reimplantation	13
MACE	10

Appendix was used in 38 patients to create a continent stoma by mitrofanoffs procedure. In 12 patients where the appendix was unsuitable or used to access the colon via the antegrade colonic enema (ACE) procedure, ileum was used by Monti's principle. We have also used ureter in 1 case to create a catheterizable stoma. We found no difference in complication rate between different types of conduit. The stoma was concealed in the umbilicus in 44 patients, the right lower abdominal wall in 6 patients and brought out through sub umbilical position in 1 patient due to short length of the conduit. We found no difference in complication rate between different sites of stoma.

Out of the 51 patients, 49 (98%) were dry during the day and night on 2-3 hourly intermittent catheterization and 1 patient has intermittent dribbling with stress incontinence

and occasional episodes of nocturnal wetting. Cystoscopy done in this child revealed wide bladder neck and is awaiting rectus sling surgery. Children are themselves performing clean intermittent catheterization (CIC) with ease while in 5 children below 5 years old had one of their parents doing CIC, mostly the mother. Children are using 10 no infant feeding tube for CIC. As patients cannot afford disposable catheters, the catheter is washed from outside and flushed from inside and dried well after every use. In this manner our patients are able to use approximately 8 catheters for 1 month without increase in risk of colonization of catheters and urinary infection.

Catheterizable conduit complications included occasional stomal leakage in early postoperative period in 2 appendicovesicostomies and 1 patient with monti channel which were treated conservatively. One patient of appendicovesicostomy developed mucosal prolapse at the stoma site. One patient with monti channel had an intra peritoneal leak requiring exploratory laprotomy and revision. Complications related to concomitant surgery included mechanical bowel obstruction in 2 patients who underwent exploratory laparotomy; vesicocutaneous fistula in 2 patients and vesicovaginal fistula in a girl with bilateral ectopic ureter which were repaired. On follow up 4 patients developed symptomatic urinary tract infection and 2 patients developed vesical calculi. Hypocalcemia with metabolic acidosis developed in 1 patient requiring supplements. These complications are summarized in Table 3.

Table 3: Complications after the Mitrofanoff procedure.

conduit complications	No. of patients
Stomal leakage	3
Mucosal prolapse at the stoma site	1
Intra peritoneal leak	1
Reservoir complications	
Mechanical bowel obstruction	2
Vesicocutaneous fistula	1
Vesicovaginal fistula	1
Vesical calculi.	2
Urinary tract infection	4
Hypocalcemia with metabolic acidosis	1

Serum creatinine -1 and 2 values and BUN -1 and 2 values were plotted in a bar diagram (Figure 3 and 4).

Among 40 patients out of 51 patients had successful stabilization of their serum creatinine and BUN values after bladder augmentation. 1 patients (patient no. 17) with normal serum Creatinine- 1 and BUN- 1 value had slightly higher serum creatinine -2 and BUN -2 values .6 patients with raised serum creatinine -1 and BUN -1 values had decline in serum creatinine 2 and BUN 2 values to normal range Out of 5 patients with raised serum creatinine -1(>2.5 mg/dl) and BUN- 1(>60

mg/dl), 2 patients had decline in serum creatinine -2 and BUN -2 values while 3 patients had a higher serum creatinine -2 and BUN -2 values eventually requiring

dialysis. This difference in outcome was statistically significant ($p < 0.01$ by Chi square test).

Figure 3: Comparison of serum creatinine-1 and serum creatinine- 2.

Figure 4: Comparison of bun-1 and bun- 2.

DISCUSSION

Following the introduction of the concept of Clean intermittent catheterisation (CIC) as a safe and acceptable method of bladder emptying by Lapides and colleagues in 1972 and the development of Mitrofanoffs procedure in 1980 has led to tremendous advancement in treatment of a incontinent child due to varied conditions with an inability to catheterize through the native urethra.² Indications for the Mitrofanoff procedure included the neuropathic bladder (conduit into the native or augmented bladder), urethral strictures, urethral injuries, and significant bladder dysfunction associated with an intact urethral sensation (e.g. posterior urethral valves, prune-belly syndrome, bladder or cloacal exstrophy and epispadias, post-radiation radiotherapy, and idiopathic dysfunctional bladder). Mitrofanoff, using the appendix as a catheterizable stoma, initially described the creation of a continent catheterizable conduit.

Appendicovesicostomy has traditionally represented an ideal conduit because of constant and reliable blood supply, supple muscular wall, and adequate lumen. We used appendix in 38 patients. When the appendix is unsuitable or used to access the colon via the ACE procedure, other structures such as the ureter, Fallopian tube and longitudinally tabularized ileal and gastric segments were all used.³ Currently, the most commonly used option is the transverse ileal (Yange Monti). In 12 of these patients, the transverse ileal (Yang-Monti) tube was used. Authors have also used ureter in 1 case to create a catheterize stoma. There was 1 case of stoma prolapse, 2 case of stomal leakage and 1 case of intraperitoneal leakage in this study. There were no reported cases of stomal stenosis in our study. On review of literature we found Thomas et al, reviewed 68 patients of mitrofanoff procedure and found 9 patients developed stomal stenosis and 4 had false passages. Narayanaswamy et al, suggested that difficulty with

catherisation was more to occur with a Yange Monti, as opposed to an appendix conduit.^{4,5} In their study 26% with appendicovesicostomies had problems with CIC whereas 60% of patients with illeovesicostomies had problems with catheterization. Castellan et al, found no difference in the incidence of complications in Yange Monti channels (23%) versus appendix conduits (21%) at a mean follow up of 4 years.⁶ Similarly, authors found no difference in complication rate between different types of conduit.

Thirty patients out of 50 underwent augmentation cystoplasty in conjunction with mitrofanoffs procedure, using ileum (17), caecum (9) and sigmoid (4), 5 patients underwent penins pouch reconstruction. In our study we found no difference in outcome between sites of implantation, or segments used for augmentation. This is similarly to the study by Piaggio et al, investigated the influence of type of conduit (appendix vs YangeMonti) and site of implantation (augmentation vs native bladder) in 41 patients with continent vesicostomies, of whom 72% also had a bladder augmentation.⁷ There was no significant difference in outcome between different types of conduit (including divided appendix), sites of implantation, or segments used for augmentation (ileum or colon). Franc-Guimond and Gonzalez also explored the outcome of 32 conduits implanted into colonic or ileal augments. At 2 years' follow up, continence rate was 87.5% while revision rate was 18%.⁸ The latter was not related to the segment of bowel into which the conduit was implanted.

The site of the stoma on the abdominal wall is carefully selected to allow easy access to the patient, provides an unrestricted route to the reservoir, as well as should be cosmetically pleasing. In present study stoma was concealed in the umbilicus in 44 patients and the right lower abdominal wall in 6 patients. No significant differences in the outcome were identified when considering the stomal site. Van Savage et al, reported complication rates for anastomoses fashioned in the lower quadrant (1 of 10) and the umbilicus (3 of 25).⁹

Authors encountered vesical calculi after augmentation cystoplasty with mitrofanoff procedure in 2 patient and 4 patients developed urinary tract infections. The etiology of stones after AC includes incomplete emptying, excessive mucus production, metabolic abnormalities and chronic bacteriuria. With generous irrigation of the pouch or augmented bladder at regular intervals, and prompt treatment of UTIs the incidence of calculus formation can be decreased. 2 patients had intestinal obstruction requiring exploratory laparotomy. Lack of extraperitonealisation of mitrofanoff channel due to which mitrofanoff channel acted as a band caused intestinal obstruction in these patients.

In this study 5 out of 51 patients were in renal failure at the time of mitrofanoffs procedure. All of these 5 patients had undergone bladder augmentation along with

mitrofanoffs procedure. Out of 5 patients with raised serum creatinine -1 (>2.5 mg/dl) and BUN -1 (>60mg/dl), 2 patients had decline in serum creatinine -2 and BUN -2 values while 3 patients had a higher serum creatinine -2 and BUN- 2 values eventually requiring dialysis. Renal failure in these patients is primarily a consequence of pre-existing renal injury and not the result of the bladder augmentation. Bruce J. Schlomer et al, also demonstrated that principal diagnosis was strongly associated with risk of decline in renal function or Chronic kidney disease (CKD) after bladder augmentation.¹⁰ Singh P et al, in their study concluded that Glomerular filtration rate $\leq 4\text{mL/min}$ and serum creatinine 1.54mg/dL at time of surgery could serve as predictors of renal function deterioration in augmentation cystoplasty in pediatric patients.¹¹ Similarly, William Bhatti a, Sudipta Sen et al, suggested that, bladder augmentation when otherwise indicated, has been beneficial in children with pre-augmentation creatinine up to 2 mg/dl.¹² Thus, bladder augmentation with mitrofanoffs procedure does not reverse renal failure although it can delay the onset of end-stage disease. Bladder augmentation with or without mitrofanoffs procedure has also been recommended as a method of preparing a dysfunctional bladder prior to renal transplantation, as the bladder could otherwise, in time, destroy the transplanted kidney, just as it destroyed the native kidneys prior to transplantation.^{13,14}

Authors present this 10-year experience of mitrofanoff procedure in children of varied conditions in a developing country where most of our patients belong to lower economic strata. Very few studies have addressed this issue. A study by Sinha S, Sen S et al, reported the experience of mitrofanoff principle in 122 children with a follow up of 2.6 years with a complication rate of 7.4% in appendicular conduits and 25.8% in ureteric conduits.¹⁵ Liard et al, reported on the 22 original patients treated by Mitrofanoff, with a minimal follow of 15 years with a 50% stoma complication rate.¹⁶ Another study by Fishwick et al, with a minimal follow up of 10 years, revealed that 4 of 8 patients (50%) requiring surgical revision.¹⁷ Authors achieved a relative continence of 97% with minimal complications in our 10yr follow up. Cost reduction by encouraging the reuse of catheters was also instrumental in better acceptance of CIC as patients cannot afford disposable catheters. All the children were satisfied with the operation and they as well as their parents felt there was definite improvement in their quality of life. All were accepted at school and among friends and older patients on follow up are in college and doing jobs.

CONCLUSION

Mitrofinoff is a safe and reliable procedure in children who are dependent on intermittent catheterisation in developing countries. Appendicovesicostomy is our first option followed by yang -monti illeovesicostomy and umbilicus being the favourable place for site of stoma. No difference in outcome was observed between different

types of conduit, site of stoma, sites of implantation, or segments used for augmentation. While stomal continence is excellent patient education family motivation and cost reduction are important factors for its lasting efficiency.

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