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A neosphincter for continent urinary catheterizable channels made from rectus abdominal muscle (Yachia principle): Preliminary clinical experience in children

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**KEYWORDS**

Mitrofanoff; Appendicovesicostomy; Urinary diversion

**Abstract**

*Purpose:* We investigated continence outcomes for patients undergoing primary or redo reconstruction of a urinary catheterizable reservoir involving the Yachia technique of intersecting two rectus abdominis strips over the outlet channel.

*Materials and methods:* A retrospective evaluation of 22 consecutive patients operated from March 2009 to August 2010 was performed, consisting of 16 primary reconstructions (Macedo catheterizable ileal reservoirs) and 6 rescue cases for leaking stomas. Our data comprised 18 spina bifida patients, 1 sacral agenesis, 1 posterior urethral valves and 1 genitourinary tuberculosis. Mean age at surgery was 8.5 years (3–21 years). We evaluated continence at 3, 6, 12 months, and at the last follow-up based on data from urinary charts.

*Results:* Mean follow-up was 21.1 months (12–29 months). Overall continence was 100% for the primary cases and 66% for the redos (2/6 failed). Three patients had initial difficulty in performing clean intermittent catheterization but this resolved with time and experience.

*Conclusion:* Using Yachia’s technique has improved the continence rate of our catheterizable reservoirs and was partially successful for suprafascial revision of incontinent conduits.

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**Introduction**

Continent urinary diversion is a well accepted method of treatment for end-stage bladder disease in children. The concept adopted in the pediatric population consists of
creating a reservoir (mostly from bowel) and an outlet channel to provide a catheterizable abdominal stoma. The appendix and the Yang-Monti channel are the most commonly used techniques [1,2]. An ileal flap conduit adjacent to the reservoir and, recently, the use of skin flaps to create catheterizable channels have also been reported as alternatives [3–7].

Stoma-related complications occur in 12%–86% of cases, especially stenosis and leakage [8–10]. These complications are related to the frequency of catheterization, technique used for the umbilical stoma (VQ, VQZ or semicircular flap), healing of the patient’s wound and technique for providing continence to the channel (imbrication, submucosal tunnel).

The Yachia principle allows creation of a neosphincter based on crossing two strips of rectal abdominal muscle in the midline over a catheterizable channel as a way to enhance resistance and reduce leakage rates in catheterizable reservoirs [11]. Herein, we investigated whether patients undergoing primary or redo reconstruction of a urinary catheterizable reservoir involving use of the Yachia technique show improved continence rates in short- and mid-term follow-up.

Material and methods

The medical records of all patients who underwent reconstruction involving the rectus abdominis muscle neosphincter (Yachia) technique, from March 2009 to August 2010, were retrospectively reviewed. This was performed either as a salvage procedure for urinary catheterizable reservoirs (Macedo) that were leaking due to valve mechanism insufficiency, or as an additional continence procedure to the Macedo technique in primary repairs. Data on the following were collected: demographics, continence, diagnosis, comitant procedures and complications.

In brief, the surgical technique included creation of the ileal continent catheterizable reservoir, made of a 35-cm segment of ileum that was detubularized to create a pouch, and an outlet tube was created from a 2.5-cm-wide flap from the anterior wall of the ileum up into its middle. Once the reservoir was completed, the continence mechanism consisted of placing 4–5 interrupted 3.0 Prolene™ sutures to embed the conduit over the seromuscular wall at the dome, according to the Nissen gastroplasty method. The dome of the reservoir was anchored to the peritoneum and abdominal wall to stabilize the angulation of the conduit over the anterior wall of the pouch and subsequently against the abdominal wall. This procedure had been described previously in detail [3,12].

Later, we separated a 1.5-cm-wide strip of rectal muscle on each side and mobilized cranially and caudally without detaching it (Fig. 1A and B). The strips were then crossed in the midline to create a neosphincter through which the outlet conduit was transposed (Fig. 1C). The conduit was then anastomosed to a pseudoumbilical skin conduit created from the initial semicircular flap skin incison with interrupted 3.0 polyglactin sutures (Fig. 2). A 12-Fr silicone tube cystostomy was left indwelling for 3 weeks. The same principle was used in the redo cases, where surgery consisted of simply detaching the conduit from the skin stoma, creating the intersected neosphincter, and passing the channel through it before re-anastomosing it to the skin [11].

Patients were followed postoperatively by ultrasonography for upper urinary tract evaluation, renal function and clinical assessment of continence, during the first year every 3 months and later every 6 months. Continence was defined as a dry interval of 4 h between clean intermittent catheterizations (CICs) registered on urinary charts.

Results

A total of 22 patients were identified (13 girls and 9 boys) with the following diagnoses: myelomeningocele in 18 patients and 1 case each of: sacral agenesis, genitourinary tuberculosis, bladder exstrophy and posterior urethral valves. Mean age at surgery was 8.5 years (3–21 years) with a mean follow-up of 21.13 months (12–29 months). Procedures associated with the bladder augmentation had been performed in 4 patients (18.2%), and included three left colon antegrade stomas [13] and a Cohen bilateral ureteral reimplantation due to concomitant vesicoureteral reflux. The Yachia procedure was performed as an adjuvant continence maneuver at primary enterocystoplasty in 16 patients and as a redo procedure to correct incontinence in 6 patients. The time required to create the neosphincter ranged from 10 to 17 min (average 12.2 min).

All stomas were located in the midline at the mean point between the pubic bone and umbilical scar. Access to the stoma was easy and CIC was performed soon after surgery, except by 3 patients (13.6%) who experienced initial pain on catheterization. These patients learned a maneuver of holding the rectus abdominis muscle with fingers and thumb, thus providing pressure relief for the conduit, until they learned to relax the muscles and catheterization became an uneventful procedure. None of these patients required an additional procedure.

Early complications recorded were partial stomal dehiscence that developed into stenosis in 1 patient (4.5%) but was treated conservatively with success. All 16 patients who underwent the Yachia continence procedure as a primary operation in association with bladder augmentation are continent (Table 1). Of the 6 patients who underwent the procedure as rescue surgery, three remained incontinent at the second follow-up (6 months). At 1-year follow-up and at final follow-up the continence rate for reoperations was 66.6% (4/6).

Discussion

The association of CIC, popularized by Lapides et al. [14], with the use of anticholinergics remains the mainstay of treatment for the neurogenic bladder. Enterocystoplasty became a useful adjunct to improve bladder compliance and preserve renal function when clinical treatment fails. Early aggressive non-surgical management may protect renal function and perhaps prevent the need for augmentation cystoplasty, although some patients still need bladder reconstruction to avoid renal function loss or to achieve continence.
Lendvay et al. reviewed augmentation cystoplasty rates in children with spina bifida from hospitals enrolled in the Pediatric Health Information System database. They extracted data on 0−19-year-old patients with diagnosis codes for spina bifida between October 1999 and September 2004. The authors found no change in augmentation rates during this time, but demonstrate significant inter-institutional variability indicating that high-volume centers seem to show better clinical results [15].

Construction of a continent urinary reservoir often requires a catheterizable channel. Application of the Mitrofanoff principle, since the initial description of appendicovesicostomy in 1980, has evolved into various conduit types with continence success rates of up to 95% [16–18]. The appendix is still the channel of choice. When the appendix is not available for urinary reconstruction, the Yang-Monti technique and the Macedo procedure are valuable alternatives [2,3]. One advantage of the Macedo procedure is that it precludes the need to adapt a tube (appendix or Yang-Monti) to create the reservoir, because detubularization and reconfiguration of the ileum produces a catheterizable reservoir.

Stomal complications found in such patients are stenosis, stomal prolapse, false passage, channel fibrosis and leakage, and altogether they range between 12% and 86% [8–10]. Thomas et al. reviewed their experience with the construction of abdominal wall stomas, specifically recording the incidence of and time to initial complication, as well as determining whether complications tend to recur during follow-up. They found 23% channel-related complications, mostly stomal stenosis, and observed their occurrence in the first year of follow-up [19].

The incidence of specific stoma-related complications is generally related to the surgical technique applied. Stomal stenosis is a commonly recognized complication in patients in whom cutaneous urinary diversion is performed. Landau et al. reported on 37 patients with Mitrofanoff urinary diversion and 13 patients with Malone antegrade continence enema (MACE) construction. The umbilicus was used for 31 conduits, the V-quadrilateral-Z (VQZ) was used for 8 and the tubular skin flap was used for 11. Patient age, gender and etiology of incontinence were similar in the three groups. All patients achieved a good cosmetic result with a hidden bowel mucosa. In the VQZ group, no patient had stomal stenosis. Five patients (45%) in the tubular skin flap group required dilation or revision for obstruction or stenosis, which was successful in 4. Eight umbilical conduits (25%) had to be dilated or revised due to stomal stenosis (6) and conduit obstruction (2). The authors suggest that the VQZ flap showed superiority over the tubular skin flap and the umbilicus for stomal construction in patients with a Mitrofanoff or MACE conduit [20]. A careful look at these data, however, reveals that the sizes of the groups were not comparable and time of follow-up was not provided.

England and Subramaniam created a VQ flap at the distal end of the Pfannenstiel incision, and compared the

Figure 1  The Yachia procedure. (A) Two non-detached rectus muscle strips of 1.5 cm. (B) Checking muscle mobility. (C) The channel in between the crossing muscles (neosphincter).

Figure 2  The VQ-plasty and cross-over technique: (A and B) operative and (C) final aspect.
Lemelle et al. and Leslie et al. showed equal results and the Monti tube of 10.7% and 12%, respectively, but et al. reported a leakage rate related to the Mitrofanoff is believed to have higher leakage rates. Narayanaswamy in studies with shorter follow-up (Table 2). The Monti tube decrease with time. This trend was also reported by others follow-up period, although the complication rate tends to decrease with time. This trend was also reported by others in studies with shorter follow-up (Table 2). The Monti tube is believed to have higher leakage rates. Narayanaswamy et al. reported a leakage rate related to the Mitrofanoff and the Monti tube of 10.7% and 12%, respectively, but Lemelle et al. and Leslie et al. showed equal results [26–28].

Nipple valve techniques are employed less often today but were used frequently in the past, mainly in the classical Mainz-pouch 1 technique. Wiesner et al. reported a continence rate of 82% with the nipple valve, but the same authors showed a higher continence rate with the appendix in situ as the outlet channel and a submucosal tunnel continence mechanism (92%) [17].

The serous-lined principle was originally described by Abol-Enein and Ghoneim for complex ureteral reimplantation [29]. The authors further described the same principle for continence of catheterizable reservoirs, and reported initial results of 91% continence and a review rate of 8.4% [18]. The same principle was employed by Macedo and Srougi as the continence mechanism for catheterizable reservoirs, and consisted of imbrication of the catheterizable channel over serous-muscular interrupted sutures [3]. An experimental ex-vivo study from the same group evaluated whether angulation of the channel over the reservoir or extension of the serous-lined tunnel was the main factor responsible for continence in this model, and concluded that the same resistance was obtained if angulation remained stable, regardless of one, two or three sutures over the channel [30]. This assumption led us to place stay sutures at the dome of the reservoir to keep the tube angulated downwards and against the abdominal wall, thus re-enforcing the valve mechanism.

We previously reported an overall initial continence rate with the ileal catheterizable technique of 80.65% (86.4% in patients < 5 years) [31]. We were not satisfied with these results, and in the intervening years have introduced minor modifications of the technique to improve continence. The use of absorbable suture material to embed the outlet tube was replaced by non-absorbable material (Prolene™). We subsequently discovered the adjuvant role of angulation of the tube against the reservoir dome and opposite to the abdominal wall to increase resistance.

We continued to search for adjunct continence mechanisms to improve our results. Yachia et al. had described a straight-forward technique to achieve continence for catheterizable channels by crossing two non-detached rectal muscle strips. They operated on 17 adult patients with bladder cancer and created a right colon reservoir [11]. We were not able to find any similar study in the pediatric population or reproduction of this method by others.

We hypothesized that the incorporation of this principle into the imbrication method we use could provide higher resistance to the outlet tube and improve our continence rates using the ileal catheterizable reservoir. We were however faced with the unknown aspects of the Yachia technique. We could not rule out ischemia of the tube at the neosphincter level nor muscle fiber atrophy after mobilization and crossing over the channel. An

<table>
<thead>
<tr>
<th>Author</th>
<th>n</th>
<th>Follow-up (years)</th>
<th>Continence (%)</th>
<th>Stenosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liard et al. [25]</td>
<td>23</td>
<td>20</td>
<td>79</td>
<td>61</td>
</tr>
<tr>
<td>Harris et al. [33]</td>
<td>50</td>
<td>4.3</td>
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<td>20</td>
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<td>Cain et al. [34]</td>
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<td>2</td>
<td>98</td>
<td>12</td>
</tr>
<tr>
<td>Narayanaswamy et al. [26]</td>
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<td>81</td>
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<tr>
<td>McAndrew and Malone [35]</td>
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<tr>
<td>Macedo et al. [23]</td>
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<td>13</td>
</tr>
<tr>
<td>Mean</td>
<td>71</td>
<td>6.4</td>
<td>90.5</td>
<td>26</td>
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</table>

Table 1 Clinical results in regard to continence.

<table>
<thead>
<tr>
<th>Author</th>
<th>3 months n (%)</th>
<th>6 months n (%)</th>
<th>12 months n (%)</th>
<th>Max. follow-up n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>16 (100)</td>
<td>16 (100)</td>
<td>16 (100)</td>
<td>16 (100)</td>
</tr>
<tr>
<td>Redo</td>
<td>3 (50)</td>
<td>3 (50)</td>
<td>4 (66.6)</td>
<td>4 (66.6)</td>
</tr>
<tr>
<td>Overall</td>
<td>19 (86.4)</td>
<td>19 (86.4)</td>
<td>20 (90.9)</td>
<td>20 (90.9)</td>
</tr>
</tbody>
</table>

Table 2 Complications of catheterizable channels: literature review.
experimental study in rabbits was designed to better evaluate the behavior of the tube and neosphincteral muscle fibers. No evidence was found of ischemic injury to the tube, and the initial mild muscular atrophy was completely restored at 16 weeks’ follow-up [32].

Conclusions

Our initial results showed 100% continence for primary repairs and 66% for redos with a mean follow-up of 21.1 months. We consider these results promising but we acknowledge a still limited observation time. On the other hand, all patients have a minimum of 1 year follow-up, probably surpassing the most critical period for occurrence of complications. We still do not know if the continence mechanism provided by the cross-over technique is passive or active, represented by contraction of the rectal abdominal muscle. We plan soon to perform a urodynamic evaluation of the outlet to record the sphincteric profile and hope to answer this question in the near future.

Conflict of interest/funding

None.

References


