

## Tap Water Irrigation and Additives to Optimize Success With the Malone Antegrade Continence Enema: The Indiana University Algorithm

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**Purpose:** We report the long-term effectiveness of standard tap water for Malone antegrade continence enema irrigation as well as our algorithm for managing refractory constipation/fecal incontinence in a large single institution experience.

**Materials and Methods:** We retrospectively reviewed the charts of 256 Malone antegrade continence enema procedures performed for chronic constipation and/or incontinence due to neuropathic bowel. Continence, type of fluid used to irrigate the colon, volume of flushes and the need for additives were recorded and a database was created. All patients were initially treated with tap water irrigation. Those in whom tap water irrigation failed underwent complete bowel cleanout with enemas and GoLYTELY® via the Malone antegrade continence enema, followed by a gradual increase in irrigation volume. If this was unsuccessful, additives of mineral oil, MiraLAX® or glycerin were added to the irrigant daily.

**Results:** A total of 236 patients with at least 6 months of followup were included in this study. Mean age at surgery was 10.2 years (range 2 to 36) and mean followup in the entire cohort was 50 months (range 6 to 115). Mean volume of colonic flushes was 642 ml (range 100 to 1,000). Of the patients 196 (83.1%) achieved total fecal continence with tap water flushes alone. Using additives increased the overall continence rate to 93.6% ( $p < 0.0001$ ).

**Conclusions:** The Malone antegrade continence enema procedure has proved invaluable for treating children with refractory constipation. When additives are used in conjunction with water flushes, they can significantly improve the overall fecal continence rate in partially continent children.

*Key Words:* spinal dysraphism, constipation, enema, fecal incontinence, water

Since the initial description of the antegrade continence enema in 1990 by Malone et al,<sup>1</sup> the MACE procedure has revolutionized treatment and improved quality of life in children with neuropathic bowel, refractory constipation and fecal incontinence. A partial or complete continence rate of 57% to 100% has been reported in the literature.<sup>2-16</sup> The definition of success and the optimal enema regimen vary among centers, and are largely a trial and error system.

We have previously reported the safety profile of using tap water enemas for washout after the MACE procedure.<sup>17</sup> Since we have accumulated significant experience with performing the MACE procedure, we performed this study with 3 objectives. 1) We evaluated the durability and effectiveness of tap water enemas alone for MACE irrigation in a large cohort of patients from a single institution. 2) We evaluated the need for and success rate of additives used in conjunction with tap water enemas in failed cases. 3) We describe our

algorithm for managing refractory constipation and fecal incontinence in patients undergoing the MACE procedure.

### MATERIALS AND METHODS

From 1997 to 2006, 256 MACE procedures were performed at our institution. A retrospective chart review of 236 patients with a minimum of 6 months of postoperative followup was performed and a database was created. Age at the MACE procedure, diagnosis of underlying neuropathic bowel, volume of washout enema, need for an additive to optimize continence outcome, continence status and followup were recorded in all patients. Continence was defined stringently as the absence of stool accidents during a 1-year interval, excluding acute food, viral or drug induced gastroenteritis.

We start MACE washouts in the postoperative period with the return of bowel activity and tolerance of oral intake. Tap water is our preferred washout solution and typically we start that at 50 ml every night. This volume is then increased by 50 ml every third night until the continence goal is achieved. We stress the fact that this process is labor intensive to caregivers and families, and it may take 4 to 6 weeks for optimal results. We have not looked specifically at time spent on the toilet, although in some cases we used additives to minimize this time. In general we encourage patients and caregivers to allow as much time as possibly needed for complete evacuation and we have not received many complaints in this regard. Some patients experience

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longer times on the toilet despite the use of additives. We believe that these patients experience motility problems (longer than usual), for which gastroenterology referrals have been made.

We found the timing of stool accidents to be the most important factor in troubleshooting partial failures (see [figure](#)). If stool accidents occur immediately or overnight, we evaluate compliance with irrigation, enema volume, time spent on the toilet and stool consistency. Increasing the enema volume by 150 to 200 ml and/or increasing the time spent on the toilet solves the problem in most cases. Furthermore, adding 30 ml mineral oil or 17 gm MiraLAX in 250 ml tap water via the MACE channel 15 to 30 minutes before instilling the remaining flush volume may help when stool consistency is hard.

Midday stool accidents, no immediate evacuation following a MACE flush or pure water evacuation following an enema flush necessitates KUB for evaluating the stool load in the colon. When the stool load is heavy, we advocate total bowel cleanout with polyethylene glycol (GoLYTELY). One liter GoLYTELY may be given through the MACE channel during 1 hour or 500 ml twice daily. This step may be repeated again the following night, if necessary. After the colon is cleaned out, we maintain patients on a regimen that adds 17 gm MiraLAX to the daily enema washout.

Patients with high rectal tone as an etiology for little or no stool evacuation, such as those with spinal cord injury or cerebral palsy, may benefit from a stimulant laxative, such

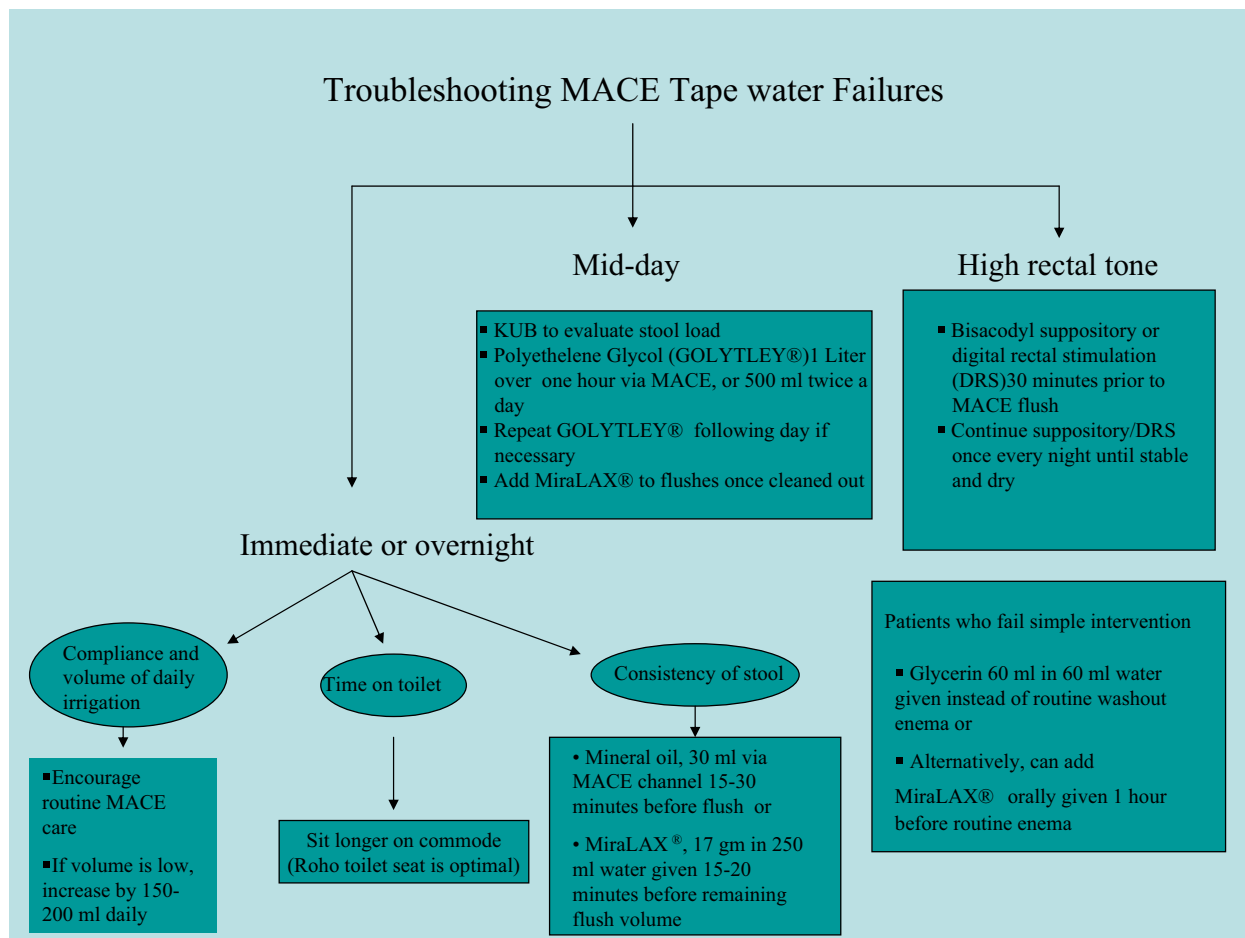
as a bisacodyl suppository or digital rectal stimulation, given 30 minutes before MACE washout. In these cases we encourage the use of a stimulant laxative or digital rectal stimulation by caregivers daily until patients are stable and dry.

Patients who fail to achieve total fecal continence with these simple measures may benefit from using glycerin instead of tap water as the main enema solution (60 ml glycerin in 60 ml water). Alternatively MiraLAX may be given orally an hour before the MACE enema.

To test the impact of additives used in conjunction with the tap water enema on the overall continence rate the McNemar test was used. To test for an association between patient age and the volume of washout enema required to achieve the continence goal the Pearson correlation coefficient was used. Patient weight was not available in the database to test whether an association could be established between weight and the volume of washout enemas. Statistical significance was considered at  $p < 0.05$ .

## RESULTS

Our study cohort included 236 patients who underwent the MACE procedure at our facility with at least 6 months of followup, of whom all are actively treated with our program. Of these patients 112 were male and 124 were female. Mean age at surgery was 10.2 years (range 2 to 36) and mean followup in the entire cohort was 50 months (range 6 to 115). The [table](#) lists the underlying etiologies of neuropathic



Troubleshooting MACE tap water failures. DRS, digital rectal stimulation

bowel. The MACE channel was created using the in situ appendicocostomy technique in 172 patients, split appendicocostomy in 23, appendicocostomy with stapled cecal extension in 9, Yang-Monti ileocostomy in 22 and colon flap coloecostomy in 10.

The mean volume of tap water used for colonic flushes was 642 ml (range 100 to 1,000). Of the patients 196 (83.1%) achieved total fecal continence with no stomal leakage and no stool accidents with tap water alone. Using our progressive program of MACE additives in patients with persistent fecal incontinence increased the overall success rate to 93.6% (McNemar's test  $p < 0.0001$ ).

There were no differences in outcomes based on age at operation. A total of 50 patients were 5 years or younger at MACE construction, of whom 3 (6%) experienced occasional fecal soiling. Similarly 12 of the remaining 186 patients (6.5%) older than 5 years were fecally incontinent. Unfortunately patient weight was not available in the database, so that an association between patient weight and the volume of washout enema could not be evaluated. However, no association could be established between patient age at the MACE procedure and the volume of washout enema required to achieve the goal.

## DISCUSSION

Since its introduction in 1990, the Malone antegrade continence enema has significantly improved quality of life and social integration in patients with neuropathic bowel and fecal incontinence.<sup>18</sup> Although modest success rates have been achieved in patients with chronic idiopathic constipation or colonic motility disorder,<sup>19</sup> the ideal patient for a MACE procedure should be older than 5 years, have a diagnosis of neuropathic bowel, an anorectal malformation or Hirschsprung's disease, and all conservative measures should first have been tried and failed.

The overall fecal continence rate after the MACE procedure varies significantly in the literature. Partial or complete continence rates of 57% to 100% have been reported previously in a relative small number of patients.<sup>2-14</sup> Furthermore, enema regimens vary among centers with most centers in the United Kingdom favoring stimulant laxatives, in contrast to saline or tap water enemas in the United States. We have previously reported the safety profile of using the tap water enema, which continues to be our pre-

ferred enema solution for MACE flushes.<sup>17</sup> Because we have accumulated extensive experience with performing the MACE procedure, we evaluated the continence rate in a large cohort of patients from a single institution as well as the longer term outcome of tap water irrigation. Moreover, we present our algorithm for managing partial or complete failures.

We have found it impossible to predict which patients will require additives postoperatively. For example, some patients had severe constipation preoperatively on KUB, although did not require additives postoperatively to achieve the goal. It is also important to realize that patients may have fecal soiling secondary to chronic constipation and/or incontinence without constipation, ie sphincter incontinence in the preoperative setting. KUB in these patients may help distinguish between these 2 entities. We believe that our patients have a combination of chronic constipation and sphincter incontinence since most of the patients in our cohort have neuropathic bowel. Since we do not believe that there is a difference in the surgical management of the 2 entities after conservative treatment fails, we have not routinely obtained KUB preoperatively.

Continence was defined stringently in our series as the absence of fecal accidents during a 1-year interval, excluding drug or viral induced gastroenteritis. With this definition 83.1% of our patients are completely dry on tap water enemas alone. Previously we have reported a 91% success rate in 127 patients who underwent a MACE procedure at our institution.<sup>20</sup> The lower success rate in the current series may be attributable to the fact that tap water only enemas may fail with time in some patients due to relapse/recurrence of chronic stool retention. Therefore, patients who failed to meet this criterion underwent a program of progressive additives, which improved our success rate to 93.6%.

We found that timing of fecal accidents is the most critical factor in troubleshooting failed cases. Early fecal accidents within a few hours of MACE washout are indicative of incomplete colonic emptying. Simple measures, such as increasing the enema volume, increasing the time spent on the toilet or in cases of hard stool consistency adding mineral oil or MiraLAX 30 minutes before washout may improve colonic emptying and render patients with partial failure completely dry. In contrast, midday accidents are most likely the result of a heavy stool colonic load. In these situations it is not uncommon for patients to experience no evacuation or evacuation of the water enema alone without stool because water passes around the heavy stool burden. KUB in these cases establishes the diagnosis and warrants complete colonic washout with GoLYTELY before resuming routine MACE enemas. If the patient is vulnerable to having a heavy stool load after complete colonic washout, the routine use of MiraLAX mixed with the MACE enema is often helpful to achieve consistent emptying.

Patients with chronic high rectal tone due to spinal cord injury or cerebral palsy represent a different problem. High rectal tone may produce functional obstruction to MACE evacuation and cause the retention of MACE fluid, which may induce autonomic dysreflexia in spinal cord injured patients. We do not advocate routine rectal stimulants (suppositories or digital rectal stimulation) in patients with high rectal tone, although this is our first line of intervention if they experienced accidents with tap water enemas alone.

In refractory cases we found that using glycerin as the only enema solution or giving MiraLAX orally an hour be-

*Etiology of chronic constipation*

Diagnosis	No. Pts (%)
Neurogenic:	226 (95.8)
Myelomeningocele	198
Sacral agenesis	8
Lipomeningocele	7
Spinal cord injury	6
Tethered spinal cord	2
Sacroccygeal teratoma	1
Transverse myelitis	1
Cerebral palsy	3
Anorectal malformation:	5 (2.1)
Imperforate anus	4
Persistent cloaca	1
Other:	5 (2.1)
Posterior urethral valves	2
Prune-belly syndrome	1
Hinman syndrome	1
Functional constipation	1

fore the MACE enema can be extremely helpful. Glycerin is an osmotic laxative that works by increasing water absorption in the colon, which in turn stimulates colonic peristalsis. The downside of using glycerin as a routine irrigant is the greater associated cost, which is often not covered by insurance.

## CONCLUSIONS

We believe that the MACE procedure continues to be an invaluable option in children with neuropathic bowel and fecal incontinence. Although MACE flushes may be labor intensive, they can achieve good long-term results even in difficult cases. A program of progressive additives, when used in conjunction with water flushes, can significantly improve the overall fecal continence rate in patients with initial failure.

### Abbreviations and Acronyms

KUB	=	plain x-ray of kidneys, ureters and bladder
MACE	=	Malone antegrade continence enema

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## DISCUSSION

*Dr. Peter Metcalfe.* How did you evaluate the sphincter tone and how many patients ended up with the Dulcolax® suppository?

*Dr. Ahmad Bani-Hani.* Basically, those kids with the increased anal tone also had spinal cord trauma rather than myelomeningocele. It is the majority and we had about 10 cases of spinal cord trauma that ended up having more of an upper motor neuron type of spastic condition with hyperreflexic bladder. The majority of these patients did not respond until we used the Dulcolax to relax the sphincter.

*Unknown.* I was just wondering if all of your antegrade continence enemas were placed into the cecum because I noticed the long washout times of 45 minutes or so. Did you think of placing any into the descending colon?

*Doctor Bani-Hani.* Our routine now is all enemas go into the cecum. We use the appendix and the in situ technique to imbricate the cecum around the appendix but all of them are in the cecum. It is an in situ technique. I do not think any of our patients have undergone any left colon enema procedures.

*Unknown.* Colonic transit through the distal colon is slow in the neuropaths particularly.

*Doctor Bani-Hani.* We agree. The mean time for our patients was around 40 minutes. If patients complain about the time they are sitting on the toilet, then we have used MiraLAX® and mixed it with the tap water flush itself, which helped minimize transit time in a lot of cases.