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Original Research:

Effects of Colon Irrigation on Serum Electrolytes

J.G. Collins, N.D. * and P. Mittman, N.D.+

*Associate Professor, National College of Naturopathic Medicine, +Director of Research, National College of Naturopathic Medicine, Portland, Oregon 97216

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Seventeen volunteers receiving a series of 3 colonic irrigation treatments during a one week period were evaluated for serum electrolyte changes following treatment. Serum electrolytes measured prior to the first treatment and immediately before and after the third treatment demonstrated significant (p>.05) decreases in serum Na+ and Cl-. These values did not fall below clinically significant levels, nor did any of the patients experience symptoms associated with hyponatremia or hypochloremia. Calcium, potassium, and phosphorus levels remained unchanged.

Introduction

Colon irrigation is a traditional naturopathic technique frequently used in the preparation for colorectal endoscopy, radiology and surgery, and for the treatment of constipation and various disorders associated with endotoxemia of fecal origin1. Several published reports have described significant, sometimes fatal, water and electrolyte imbalances following enemas or colonic irrigation 2-11 (Table 4). To address this issue, we compared serum electrolyte concentrations before and after a series of three colonic treatments given in a one week period using filtered tapwater. The patients seen in this study were ambulatory and free of serious pathology.

Methods

Seventeen volunteers (11 females, 6 males) ages ranging from 22-54 years, were recruited by advertisement from the student externs and patient population at the Portland Naturopathic Clinic. Pre-experiment history and physical examination were performed to exclude any person with cardiovascular disease, including hypertension, congestive heart failure and angina, renal or metabolic disease, bowel obstruction or inflammatory disease.

Serum electrolytes were measured by a single reference laboratory, using an automated multi-channel instrument, prior to the first treatment and immediately before and after the third treatment.

Treatments were administered by trained personnel using a Dotolo Model 1085-SV Colon Hydrotherapy Instrument equipped with an inline cotton matrix filter capable of removing particles greater than 5 microns in diameter. Water temperature was monitored in line and kept to a range of between 95 to 100 degrees Fahrenheit. Infusion pressure was limited to less than 1.25 pounds per square inch, and the number of fill-empty cycles was recorded for each treatment. The water was retained and released under operator control according to subject comfort. Each treatment consisted of repeated fill-empty cycles for approximately 45-60 minutes. Abdominal massage was applied during the evacuation phase of each cycle according to subject comfort. Subjects were placed in supine or left lateral decubitus position during the treatment. After treatment, the subjects were instructed to evacuate remaining stool and water in a sitting position prior to post-treatment laboratory measurement.

Serum electrolytes were evaluated by one way analysis of variance for comparisons between the three groups. Two-tailed T-tests were performed to analyse differences between the two groups. All hypothesis tests were done with p=.05 as a significance level.

Results

Seventeen individuals, 11 female and 6 male, were enrolled in the study. All completed the series of three colonic hydrotherapy treatments without complications or complaints. The serum electrolyte values taken at baseline, immediately prior to 3rd treatment, and immediately following the 3rd treatment are presented in Table 1.

Several subjects experienced altered serum electrolytes. These included elevated potassium levels in one subject recorded after the final treatment, and lowered serum sodium in a second subject. Three subjects had slightly elevated serum phosphorus levels. Four had slightly elevated serum chloride levels. None of the subjects experienced any discomfort or complications from the treatments.

Significant variations in pre- and post-treatment values were noted in serum sodium and chloride levels (Table 2). The samples taken immediately after the third treatment demonstrated significantly lower sodium and chloride levels than both the baseline and pre-3rd treatment samples (Table 3).

Variations in pre and post treatment calcium, potassium and phosphorus levels were not significant (Tables 2 and 3).

Discussion

In the present study, 17 healthy volunteers with no history of bowel pathology were subjected to moderately vigorous colonic irrigation without any resulting symptoms in spite of the occurence of some disturbances in several serum electrolytes. The frequency and technique of the treatments was chosen to represent common practice among naturopathic physicians and colon hydrotherapists.

This study provides grounds for safe use of colon hydrotherapy in patients without high risk of water intoxication. Table 4 summarizes the history of published reports of complications following enemas. Jolley reported the death of a 4 year old girl with no prior history of bowel disease, following enemas equivalent to about 15% of body weight.4 In 1958 Ziskind and Gellis reviewed the incidence and mechanisms of water intoxication via enemas.7 In their own experiment they were unable to demonstrate electrolyte or clinical complications following water enemas of a volume equivalent to 3.5% body weight in 11 children with "normal" colon function. On the contrary, they reported five cases of electrolyte imbalance following rectal infusion of water equivalent to 2.5 to 3.5% body weight in children with congenital megacolon or chronic atonic constipation. They concluded that "in all cases of fatal water intoxication following enemas... hypotonic solutions were administered by several routes many times in succession before producing symptoms." They also reported one case of severe electrolyte imbalance in a febrile child given seven enemas in four hours totaling over 60% of body weight. This child had no prior history of bowel dysfunction, but was experiencing febrile seizures before and during the series of enemas. In 1976, Jacob et al. described death due to hyponatremia and bowel perforation in a 14 month-old girl without prior bowel abnormality following enemas of 9% body weight.8

	POTASSIUM			SODIUM			CHLORIDE			CALCIUM			PHOSPHORUS		
Subject	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	4.6	4.6	3.9	144	139	138	107	104	103	9.1	9.5	9.2	3.1	3.6	3.3
2	4.1	4.2	4.4	144	144	142	104	105	102	9.7	10.1	10.2	3.5	4.1	4.2
3	4.4	4.2	4.3	140	144	144	106	104	105	9.2	9.7	9.3	4.6	3.4	3.7
4	4.3	4.2	4.0	138	134	133	106	105	103	9.8	8.8	9.1	4.3	3.1	3.1
5	5.0	4.5	4.4	144	142	141	105	102	102	10.0	9.6	9.4	4.4	3.8	3.9
6	4.0	3.7	4.1	144	142	144	105	103	105	9.9	10.3	10.4	3.4	3.0	2.6
7	4.3	4.1	4.1	142	143	141	105	106	105	9.6	9.5	9.6	3.8	3.4	3.7
8	4.4	4.8	4.5	140	140	139	106	109	106	9.5	9.0	9.3	4.3	4.6	4.8
9	3.8	3.9	4.6	142	145	145	103	109	108	9.1	9.2	9.3	3.2	2.4	3.3
10	4.0	3.8	6.2	141	142	139	109	106	108	8.6	8.7	8.9	3.8	3.5	3.6
11	4.6	4.4	3.9	140	141	138	107	107	105	9.1	9.1	8.5	2.6	2.8	2.8
12	4.6	4.8	4.3	144	144	142	107	106	106	10.1	9.4	9.5	3.5	3.1	3.3
13	4.1	4.1	3.7	143	142	141	110	108	107	9.3	9.3	9.2	3.3	3.5	3.4
14	3.9	4.1	4.0	141	142	139	104	106	104	9.7	9.5	9.3	3.4	3.7	3.2
15	4.7	5.2	5.1	148	143	141	108	104	104	9.6	9.7	9.5	4.2	4.6	4.4
16	4.1	4.2	4.2	143	139	136	104	105	103	9.9	9.1	9.2	4.5	3.5	3.5
17	4.0	3.8	3.6	140	140	139	105	104	103	9.4	9.2	9.4	3.3	4.0	4.0

TABLE 1. Serum electrolytes (n = 17). 1 = pretreatment. 2= prior to 3rd treatment. 3= after 3rd treatment

It is clear from the above reports that tapwater enemas can indeed be instruments of harm and even death. As the usual colonic irrigation technique employs tapwater, it is desirable to establish criteria for assessing risk. A review of the mechanisms involved in water intoxication is of interest at this point.

When hypotonic solutions such as tapwater are placed in the colon, a quot;water reservoirquot; is created which is rapidly absorbed by passive diffusion into the capillary network of the colonic mucosa along osmotic gradients. At the same time, there is an osmotically-driven loss of plasma electrolytes into this hypotonic reservoir.12,13 As circulating plasma concentrations of electrolytes decrease and plasma water increases, tissue cells are also forced to equilibrate water and electrolytes, resulting in tissue edema, including increased intracranial pressure.14 This latter phenomenon was demonstrated on laboratory animals by Rowntree in 1926 (15) and clinically confirmed by several accidental cases in humans (Table 2). The clinical findings in cases of acute water intoxication are those of hyponatremia, hypokalemia, acid-base imbalance and increased intracranial pressure. Symptoms of water intoxication include weakness, anorexia, sweating, abdominal distension, increased urination of very dilute urine, cyanosis, pulmonary edema, confusion, coma, convulsions and death due to cerebral and/or pulmonary edema.2,10

The extent to which water intoxication occurs in any case will be determined by several factors:

i. Pretreatment dilution or depletion of serum electrolytes following dietary re-striction, parenteral fluid administration, hemorrhage, renal disease or heart failure will decrease the body's ability to compensate for rapid absorption of hypotonic fluids.

ii. The osmolality of fluids infused into the colon determines the rate and direction of net electrolyte exchange between the serum and the intracolonic fluid reservoir. Tapwater is typically hypotonic for all key serum electrolytes.

iii. The larger the total surface area of membrane in contact with the hypotonic reservoir within the gut lumen, the greater the loss of serum electrolytes. This is a function of the degree of "stretch" to the colonic mucosa caused by the hydrostatic pressure of the enema fluid. This surface area is larger in patients with distended colons, as in atony and congenital megacolon.

	POTASSIUM	SODIUM	CHLORIDE	CALCIUM	PHOSPHORUS
Analysis of Variance P Value	.96	.004*	.31*	.05	.004
MEAN #1 #2 #3	 4.38 4.37 4.31	 142.24 141.53 140.12	 105.94 105.47 104.65	 9.51 9.39 9.37	 3.72 3.52 3.58
SD #1 #2 #3	 .33 .40 .60	 2.39 2.63 3.02	 1.89 1.97 1.90	 .40 .42 .43	 .58 .58 .56

TABLE 2. Serum electrolyte levels pre and post colon hydrotherapy treatment. * = significant at 0.05 level. #1 = pretreatment. #2 = prior to 3rd treatment. #3 = after 3rd treatment.

SAMPLES COMPARED	SAMPLE MEANS	DIFFERENCE	PROBABILITY
K1 / K2	4.29/4.27	0.02	.78
K1 / K3	4.29/4.31	-0.03	.89
K2 / K3	4.27/4.31	-0.04	.81
Na1 / Na2	142.24/141.53	0.71	.29
Na1 / Na3	142.24/140.12	2.12	.01*
Na2 / Na3	141.53/140.12	1.41	.0005*
Cl1 / Cl2	105.94/105.47	0.47	.46
Cl1 / Cl3	105.94/104.65	0.29	.02*
Cl2 / Cl3	105.47/104.65	0.82	.04*
Ca1 / Ca2	9.51/9.39	0.11	.32
Ca1 / Ca3	9.51/9.37	0.14	.19
Ca2 / Ca3	9.39/9.37	0.02	.71
P1 / P2	3.72/3.52	0.20	.23
P1 / P3	3.72/3.58	0.14	.33
P2 / P3	3.52/3.58	-0.05	.51

TABLE 3. Sample means, difference and T-Test values. * = significant at the 0.05 level.

AUTHOR	REF	CASE	COMPLICATIONS	VOLUME ADMINISTERED	COMMENTS
Helwig	2	50 y.o. F	Death due to edema of brain and liver	9000 cc protoclysis	Infusion over 30 hrs. Protoclysis- bowel evacu-ation not allowed
Hiatt	3	3 children	Acute shock	Tapwater enema "moderate size" 1000cc	Congenital megacolon
		5 y.o. F	Death	1000cc	Congenital megacolon
		25 cases	Weakness, anorexia, sweating	1000cc	Congenital megacolon
Jolleys	4	4 y.o. F	Shock, coma, seizures, death after 20 hours	3150cc	No past history given
Richards & Hyatt	5	9 cases 1-6 y.o.	Shock, cyanosis pulmonary edema, death in 2 cases	500-7700cc	Congenital megacolon
Dunning	6	29 y.o. M	Weakness, hypokalemia	1500-3500cc	Post-polio paralysis chronic constipation acute UTI
Ziskind	7	7 y.o. M	Shock, coma , death	2000cc	Probable congenital megacolon
		4 y.o. F	Vomiting, seizures	4000cc	Congenital megacolon
		2.5 y.o. F	Seizures	7000cc (50% BW)	No bowel disease
Jacob et al.	8	14 m.o. F	Respiratory arrest, bowel perforation	1500cc (10% BW)	No prior bowel disease
Eisele & Reay	9	46 y.o. F	Seizures, coma, cardiorespiratory arrest, death	Approx. 20 coffee enemas in 24 hr. period	Severe RUQ pain prior to enemas
		37 y.o. F	*Death due to electrolyte imbalance	Coffee enema, 4000cc for weeks	Metastatic breast CA No prior bowel diseae

TABLE 4. Reported complications of hypotonic enemas. BW= body weight. * In all cases where data were available, serum electrolytes disturbances were found.

iv. Greater duration of retention of the hypotonic solution leads to greater elec-trolyte depletion. This factor is depend-ent on gut motility and enema technique, and poses an increased risk in patients with local or systemic necrologic deficits such a congenital megacolon or spinal paralysis. The use of isotonic electrolyte solutions has been necessary to prevent complications of frequent enemas in patients with impaired motility. Simple instructions for the preparation of iso-tonic solutions are available.5,1

v. Serum dilution by hypotonic solutions is proportional to the hydrostatic pressure exerted by that solution upon the colonic mucosa. Bowel tone and enema technique are the controlling factors. The typical hospital enema delivers pressures of 2-4 psi, depending on the height at which the canister is held. Pressure in our study was 1.25 psi.

vi. The greater the total volume of the hypotonic solution entering the body (by any route), the greater the likelihood of water intoxication.

vii. The ability of the kidneys to excrete dilute urine determines the ability to recover from acute water overload.

Important differences exist between conventional enemas and colonic irrigation of the type used for the present study. First, enemas are usually a measured volume, typically one-half liter for children and one to three liters for adults. Many colonic irrigation instruments, including the one used for our study, provide no means of volume measurement. However, reported cases of water intoxication in patients without bowel pathology occurred in enemas of 1500 to 7000 cc in children and several liters per day for many consecutive days in adults. In our study, most subjects underwent 18 to 20 intake-output cycles per treatment, and many remarked that the volume of water was very large in comparison with previous treatments they had received. However, closed system colon irrigation equipment, such as that used in our study, uses a considerable volume of water to flush the tubing during the evacuation stage of each fill--empty cycle. Thus we were unable to measure the exact volume of water entering the colon during any treatment.

Secondly, enemas are usually expelled in a sitting position after brief retention, while colonic irrigation fluid is expelled in a lying position, under therapist control. Colonic irrigation probably allows for greater retention of water in the colon than does enemas.

In spite of the considerable duration of treatment and volume of water used in our study, the subjects experienced none of the symptoms of water intoxication. Our experience at the Portland Naturopathic Clinic has been that even in debilitated and chronically constipated patients, serious reactions to colonic hydrotherapy has not occurred.

The data presented here may help support the safety of hypotonic solutions employed in colonic irrigation in normal patients with no known risk factors for acute water intoxication, such as neurogenic constipation, heart failure, renal failure and recent fluid electrolyte depletion or dilution. Further study is warranted to determine the effect of colonic irrigation on water and electrolyte balance in patients at risk of water intoxication, including the elderly, who are more prone to cardiovascular complications of electrolyte depletion.16 These studies should include measurement of the infused water volume, duration of water retention, and the mineral concentration of the solutions infused into the colon with each treatment.

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