CHLORIDES IN OBSTRUCTED BOWEL FLUID

by

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Introduction: Purpose of the Problem

In high obstruction the intestine becomes distended but empties itself often by means of reflex vomiting. This constant filling and then emptying throws the digestive juices out of the body. As they contain large amounts of sodium chloride soon there is an acute depletion which may cause the death of the animal.

In low obstruction of the small intestine the conditions are somewhat different. There is an accumulation of digestive juices in the intestine above the point of obstruction, but there is little or no loss of this material by vomiting. The intestine is distended and atonic, holding a quantity of this trapped fluid. If this fluid contained large amounts of chloride, one could explain the daath of the animal on the basis that this storing up would be as effective a means for depletion as actual loss outside the body. It was with this possibility in mind that a study of the chloride content of this fluid was instigated.

Previous work on the subject:

In reviewing the enormous literature on obstruction,

but one direct reference to the problem was noted. This appeared in a paper by O. H. Wangensteen[1] where he mentioned a case of human obstruction in which the chloride content of the fluid was stated as 10 per cent. This was a personal communication to him by Doctor George Fahr.

Other investigators mention the loss of chlorides to the animal by this method. Among these are Walters and Bollman[2] and also Herrin and Meek.[3] In none of the above work was an actual study made of the chloride loss through the accumulated fluid above the obstruction.

Method of Procedure

Three groups of experiments were used to gather this information: First, the sodium chloride content of fluid in distended closed intestinal loops was estimated, since these simulate intestinal obstruction. Second, in a series of eight dogs with simple obstruction the fluid above the point of obstruction was analyzed. Third, quantitative tests of the fluid from certain human cases of obstruction were made.

First Group:

Six dogs with chronic closed ileal loops[4] were available. At times these dogs had what we are pleased to call "blow ups"; that is, without preliminary sign the loop

became filled with fluid in the course of about twenty four hours. At this time reflex vomiting set in and the animal showed clinical signs of obstruction. To relieve these animals of their intractable nausea and vomiting, the fluid was aspirated from the loop. This was considered analagous to the fluid above an obstruction. Varying amounts of fluid were removed depending on the size of the loop. This material was analyzed for its sodium chloride content (technique below).

Second Group:

Here it was deemed advisable to produce some simple obstructions in dogs at varying levels in the intestinal tract. The positions varied from 18 cm. below the pylorus to 22 cm. above the caecum. The duration of obstruction ranged from two to nineteen days. The actual work was carried out as follows: Under rigid aseptic technique the abdomens of healthy, etherized dogs were opened. With as much care as possible the intestine at the point decided on for ligature was brought through a right rectus incision. A piece of clean folded gauze about half an inch wide was used as a ligature. This was slipped through a hole in the mesentery as close as possible to the gut so as to

avoid catching any of the larger vessels. When tied this approximated an obstruction due to an adhesive band, and would be classified by Foster[5] as "a simple obstruction". The abdomen was closed in three layers, using No. 2 plain catgut on the peritoneum and rectus muscle fascia and interrupted linen in the skin.

These animals were placed in spacious quarters and supplied with water and food. Their general condition was noted twice a day and especial notice given to the symptom of vomiting. After varying lengths of time depending upon the location of the obstruction, these animals were chloroformed and carefully autopsied.

A mid line incision from the xiphoid process of the sterum to the symphysis pubis was made. The bowel ligature was found and the distended loop lifted up out of the abdomen so that the proximal ending of the distended segment could be recognized. A ligature was then placed at this point to prevent loss of obstruction fluid. Now the bowel was cut loose from the mesentery and removed from the abdomen. Measurements of the length and greatest width of the distension were made and the gross pathology of the loop wall observed. The fluid was then removed from the intestine and measured before being analyzed

for sodium chloride per cent. From the above data the total quantity of chloride was estimated.

In two animals of this series daily blood chloride estimations were made. Five cc. of blood was removed from the heart at about 10:00 A. M. each morning until the animals were posted.

Third Group:

In cases of obstruction in man, operated upon, a quantity of the fluid above the obstruction was obtained (by needling the gut). This was analyzed for its sodium chloride content. The clinical history and the operative findings were recorded in these cases.

Technique of Chloride Analysis:

The method of Volhard[6] was used on the intestinal fluids. Some of them had to be cantrifugated before they could be used on account of extreme turbidity. The blood chlorides were estimated by Whitehorn's method.[7]

Results:

The conditions in the first series were quite uniform. All the animals had closed chronic loops either of the jejunum or the ileum. Such loops may from different causes

become distended with fluid. As the distension increases a reflex nausea and vomiting is produced. Fluids were aspirated upon the appearance of the above symptoms. Under these circumstances fluids have been shown to contain a normal enzyme concentration (Schwictenburg and Burget).[8] The experiment was repeated as often as ten times on the same animal. In all, twenty-seven different fluids were tested for chloride concentration. While there was a variation ranging from 0.60% to 0.96%, the average concentration was 0.805%. The results are given in toto in table 1.

Table I

Chloride Content Of
Closed Distended Loop Fluid

Dog	No. 150	No. 151	No. 152	No. 153	No. 154	No. 142
Per	0.61	0.75	0.82	0.85	0.79	0.93
Cent	0.60	0.74	0.88	0.87	0.85	
Sodium		0.88	0.85	0.79		
Chloride		0.88	0.94	0.82		
		0.85	0.96	0.83		
			0.85			
			0.75			
			0.88			
			0.85			
			0.75			

The average of the group was 0.805%.

In the second series of experiments simple obstructions were made in normal dogs at various levels in the small intestine. These results are perhaps best given in protocal form.

Experiment I.

July 18, 1932. Two ligatures were placed about the intestine; the upper was 20 cm. from the pylorus, the lower 12 cm. below the first.

July 19, 1932. The dog vomited twice; drank water but would not eat.

July 20, 1932. No vomiting observed. At 3:00 P. M. the dog was chloroformed and autopsied.

The position of the ligatures, as stated above, was verified. Above the upper ligature and in the loop, the intestine was cyanosed but not distended. Twenty cc. of thick, brown fluid was removed from above the upper ligature, and two cc. from the closed segment. Analyses of fluids showed 0.905% NaCl above the obstruction and 0.823% in the closed segment.

The amount of chloride loss by obstruded and closed segments amounted to only 0.19 grams.

Experiment 2.

July 22, 1932. A 25 cm. segment was made in the jejunum about 15 cm. from the pylorus. The dog vomited once July 23.

July 24, 1932. Condition good; no vomiting.

July 25, 1932. The animal was autopsied.

The bowel was found matted together with a slimy exudate. Twenty cc. of thick, gray-colored fluid was obtained from the segment. At analysis this showed 0.22% NaCl, or 0.04 grams NaCl lost to the animal.

Experiment 3.

July 26, 1932. An obstruction was made in the ileum.

July 27, 1932. The dog vomited once. The condition of the animal was good. It drank water but did not vomit during the next four days.

August 2, 1932. Autopsy showed a bowel greatly dilated for 36 cm. above the point of obstruction. The ligature was 24 cm. above the ileo-caecal valve. Seventy-five cc. of fluid obtained from the bluish white atonic gut showed 0.47% concentration NaCl. This meant a loss of 0.35 grams sodium chloride.

Experiment 4.

August 1, 1932. A ligature was placed about 50 cm. distal to the pylorus on the intestine of an apparently healthy dog. No unusual symptoms were noticed until on the Seventh of August vomiting occurred once. On this day autopsy revealed a bowel dilated and atonic for a distance of 25 cm. above the ligature but of good color. It held 100 cc. of brown fluid which contained 0.55% NaCl, or 0.55 grams of NaCl. This was a case of relatively high obstruction of six days' duration which showed little vomiting and a very small amount of chloride in the obstructed fluid.

Experiment 5.

August 3, 1932. In this dog the intestine was obstructed by ligature 25 cm. above the caecum. It was observed daily as has been described. No vomiting occurred, but distension was marked. On August 10th at autopsy a loop of dilated intestine was found extending from the pylorus to a point 106 cm. down the intestine. The bowel was bluish white, greatly dilated, and atonic. It contained 100 cc. of 0.47% NaCl, or 0.47 grams of NaCl.

This was a relatively low complete small intestine obstruction of seven days' duration which produced much

distension, a rather small amount of fluid, and no vomiting.

Experiment 6.

August 23, 1932. The intestine of this dog was obstructed at a point 20 cm. above the caecum. A blood chloride estimation made at this time showed 493 mgs. per 100 cc. of blood.

August 24, 1932. No vomiting.

August 25, 1932. Blood chlorides 494 mgs. per 100 cc. The dog had not vomited. He ate a little and drank small quantities of water.

August 26, 1932. Condition good.

August 27, 1932. Blood chlorides 476.19 mgs. per 100 cc. The dog still ate.

August 28, 1932. No vomiting noted.

August 29, 1932. Blood chlorides 511.00 mgs. per 100 cc. The dog vomited but ate shortly afterward.

August 30, 1932. Dog vomited once, but still ate and drank. There was marked distension and very marked visible peristalsis.

August 31, 1932. Blood chlorides 513.1 mgs. per 100 cc.

September 1, 1932. Dog vomited once.

September 2, 1932. Dog passed two small scyballae. Blood chlorides 508 mgs. per 100 cc.

September 3, 1932. Dog showed dehydration. No vomiting.

September 4, 1932. Blood chlorides 476 mgs. per 100 cc.

September 5, 1932. No vomiting.

September 6, 1932. Blood chlorides 503 mgs. per 100 cc. Dog ate and passed a small liquid stool.

September 7, 1932. Dog showed visible peristalsis. Vomited once.

September 8 and 9, 1932. Condition unchanged.

September 10, 1932. Blood chlorides 512 mgs. per 100 cc. Small stool passed.

September 11, 1932. No vomiting.

September 12, 1932. Dog showed signs of emaciation. Blood chlorides 518 mgs. per 100 cc.

September 12, 1932. Dog chloroformed.

At autopsy ligature was found 20 cm. above the caecum. Above this the bowel was distended for 100 cm. The widest diameter was 5 cm. The intestine was pale and atonic. Two hundred and fifty cc. of thick green material was found. It was alkaline in reaction and

contained 0.26% NaCl, or 0.65 grams of NaCl.

This was a low obstruction of nineteen days' duration. The blood chlorides showed little lowering nor was there much NaCl lost into the bowel. Dehydration and starvation complicated the picture and lack of hematecrit readings minimized the value of the blood chloride estimations. This dog ate and drank without much vomiting which probably also accounted for the maintenance of the blood chlorides. One thing was evident, however, that NaCl was not accumulated in the obstructed fluid.

Experiment 7.

January 1, 1933. Obstruction made 25 cm. below the pylorus.

January 2, 1933. Green vomitus. Dog drank 1,000 cc. H_2O; vomited at once.

January 3, 1933. Vomited three times; would not eat.

January 4, 1933. Vomited three times.

January 5, 1933. Vomited two times.

January 6, 1933. Vomited once.

January 7, 1933. No vomiting. The dog was weak, dehydrated and moribund.

January 8, 1933. At autopsy a moderately distended bowel was found extending from the pylorus to the ligature. It contained 55 cc. of brown, slightly alkaline fluid. The stomach contained 200 cc. of fluid. 0.7% NaCl was found in both the stomach and the obstruction fluid. 0.38 grams of NaCl in the obstructed materials. This dog showed some evidence of peritonitis.

This was a high obstruction of seven days' duration in which the animal underwent dehydration. There was a negligible chloride loss in the obstructed fluid.

Experiment 8.

February 11, 1933. A ligature was placed 36 cm. from the caecum in an apparently healthy dog. From this day until the day of autopsy, there was daily inspection of the animal but at no time did he vomit. He drank water sparingly but would not eat.

February 22, 1933. The dog was chloroformed and the intestinal tract removed as previously described. From the point of obstruction upward for 36 cm. the gut was markedly distended, having a diameter of five cm. just above the ligature. It was pale and very thin walled. There were 300 cc. of fluid testing 0.32% NaCl; thus the bowel contained 0.9 grams of NaCl.

This was one of the most markedly distended bowels

and from a dog which did not vomit, yet the chloride loss was less than one gram.

Experiment 9.

February 15, 1933. A ligature was placed about 120 cm. proximal to the caecum in a dog's intestine.

February 16, 17, 1933. No vomiting.

February 18, 1933. The dog was chloroformed and the ligature found surrounded by a well walled off abscess. The bowel above the point of obstruction contained 50 cc. of fluid which showed 0.52% NaCl concentration on analysis, or 0.26 grams of NaCl all told.

A mid ileal obstruction of three days' duration was not productive of vomiting. The fluid was small in amount and of low NaCl concentration.

In the third group but one case of human obstruction was available. This occurred in a patient who showed signs of an ileal obstruction and was operated upon. The diagnosis was borne out but the distension was more marked than was expected. An enterostomy was done and about 1,000 cc. of brown fluid removed. This fluid was found to contain 0.74% NaCl, making 7.4 grams present in the obstructed bowel.

Therapy before the operation consisted of an 2,000 cc. hyperdermoclysis of 0.9% NaCl. Blood chlorides were not done.

A simple ilealobstruction of five days' duration in a human produced 1,000 cc. of obstructed fluid of 0.74% NaCl concentration. This represented a loss of 7.4 grams to the patient. The results here were complicated by the fact that the patient received therapeutic salt injections.

Discussion of the results:

In the first group of experiments the average per cent sodium chloride was 0.805%. It was thought that since this figure was obtained from an average of 27 instances of distension in six dogs and since there was very little variation in the figures that this represented the true excretion by the loop. The fluid was never analyzed unless it came from a dog showing signs of obstruction. It is realized here, however, that if chlorides were thrown into the intestine during an obstruction, a short loop could not show the actual gram loss that could occur in a long segment of bowel.

In a long segment, such as was afforded in all the experiments in group two, the grams of sodium chloride

lost averaged 0.42 grams. An attempt was made to correlate the amount lost with the height of the obstruction; since the more active higher segments might be expected to excrete more.[9] No such conclusion could be drawn from these experiments. The variable of duration of time of obstruction would necessarily overshadow this correlation. Nor could a correlation of grams of sodium chloride lost and extent of time of obstruction be found. Still other factors would enter into this: the position of the obstruction, the amount of vomiting, and the condition of the animal. It was considered fitting to leave such attempts to further experiments.

In the third group to date only one experiment has been done. It was hoped here to have had at least six. The extreme paucity of simple obstruction in humans at the Multnomah County Hospital this past six months made this impossible. The one case on which data was obtained showed a low excretion of sodium chloride into the loop. This observation agrees with the experimental findings.

Conclusions

These observations indicate that sodium chloride does not rise above normal concentration in the obstructed bowel. It would also seem that it is not excreted into the lumen under these conditions. It follows, therefore, that loss of chlorides in this manner is not of clinical importance.

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