

THE SIMILARITY IN EFFECT OF EXPERIMENTAL HIGH  
INTESTINAL OBSTRUCTION AND HIGH COMPLETE  
INTESTINAL FISTULA\*

BY JOHN J. MORTON, M.D. AND HERMAN E. PEARSE, JR., M.D.  
OF ROCHESTER, N. Y.

FROM THE UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE

FOR several years now, a debate has been going on between investigators engaged in the study of intestinal obstruction. It is generally conceded that there is a wide difference between strangulation and simple obstruction. In strangulation every one agrees that toxæmia is a prominent feature, but in simple obstruction there has been a difference of opinion. One group believes that toxæmia plays an important rôle here also; but the other workers hold that the loss by vomiting of fluids, salts, and the products of normal secretions from the upper intestinal canal is responsible for the train of symptoms produced. Several ingenious methods of experiment have been designed to preserve these materials in obstructed animals. The resulting long survival and good condition of these obstructed animals lend weight to the argument against the toxæmia theory.

It seemed to us that a crucial test of the nontoxic hypothesis could be offered by comparing the picture resulting from the loss of the upper intestinal secretions through vomiting in obstructions at a given point with that associated with an equally effective loss of these secretions through complete intestinal fistula at the same level. If there is no toxic absorption from the obstructed loops involved, but simply an emptying of their secretions, there should be no difference in the effect produced, whether the emptying be through the stomach or through a fistula. Accordingly, such comparisons were made in the following experiments.

Twenty-four albino rats were completely obstructed below the level of the biliary and pancreatic ducts by tying a tape across the bowel. This point measured one and one-half inches (3.8 centimetres) from the pylorus. The average time of survival was found to be thirty hours, with extremes of twenty hours and sixty hours.

Twenty-four albino rats had the intestine divided at the same level. The lower end in each instance was tied off with a tape, but the upper end was sutured with a wide open mouth to the cutaneous surface, establishing a complete fistula. The average time of survival was found to be thirty-three hours, with extremes of twenty hours and sixty hours. The results of these survival experiments are shown in Chart I. Ether anæsthesia was used throughout. There was no evidence of peritonitis in either series.

Six dogs were obstructed at a point ten inches (25.4 centimetres) below

---

\* Presented before the University of Rochester Medical Society, February 16, 1931.

the duodeno-jejunal ligament by dividing the bowel at this point and turning in the ends under purse-string sutures. The average time of survival was

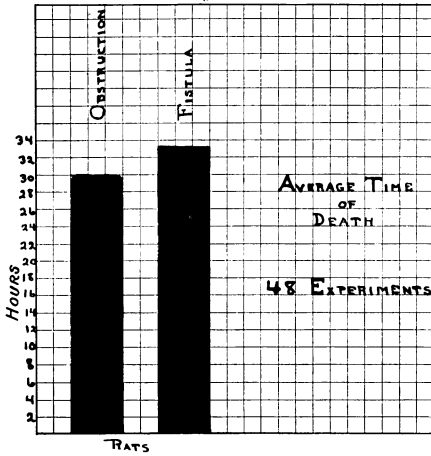


CHART 1.—The average time of death in twenty-four rats with obstruction is thirty hours. The average time of death in fistula at the same place is thirty-three hours.

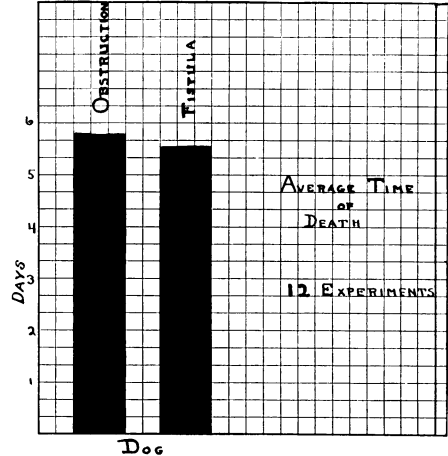


CHART 2.—In dogs the animals with fistula died sooner than those with obstruction. A reversal of the picture in rats.

five and four-fifths days. Six dogs had complete fistulas established at the same level, the upper end of the divided bowel in each instance being sutured

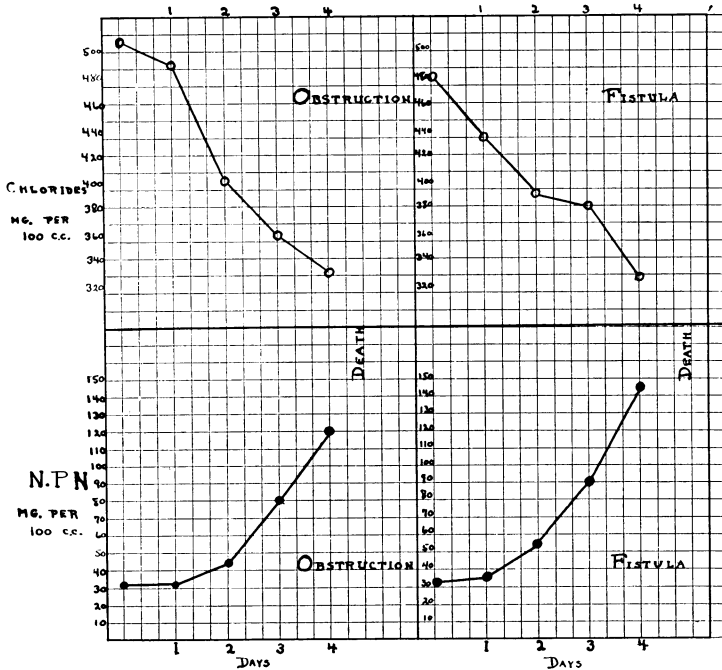


CHART 3.—An example of the blood-chemistry changes in dogs with obstruction and fistula at the same level. The similarity in the picture is very striking.

with wide-open mouth to the cutaneous surface. The average time of survival of these animals was five and one-half days. (Chart 2.) Ether

RESULTS OF INTESTINAL OBSTRUCTION AND OF FISTULA

anæsthesia was used throughout. There was no evidence of peritonitis in either series.

Comparisons between the essential blood-chemical changes were made in the dogs with complete fistulas and those with obstruction. The nonprotein nitrogen and the sodium-chloride readings were practically identical in the two series. Individual charts of two animals bringing out this similarity are shown in Chart 3.

The table of the chemical changes in the blood of the dogs with complete jejunal fistulas is here appended. (Table I.) The tables of the chemical changes in the blood of the dogs with complete jejunal obstructions at the same level were previously published.<sup>1</sup> The nonprotein nitrogen of the whole blood was determined by the method of Folin and Wu, and the chlorides by a modification of the method of Van Slyke.

TABLE I

*Complete Fistula Ten Inches Below Duodeno-jejunal Ligament*

Blood Amount per 100 cubic centimetres

Dog No.	Day After Operation	Total Nonprotein Nitrogen, Mg.	Chlorides Mg.
30-214	0	39.8	462.2
	1	64.2	310.1
	2	152.8	257.4
	3		Dead
30-194	0	32.0	379.7
	1	35.4	438.8
	2	54.2	392.0
	3	89.6	380.3
	4	146.4	327.6
	5		Dead
30-161	0	33.4	456.3
	1	39.2	409.5
	2	41.8	339.3
	3	49.0	339.0
	4	71.6	280.8
	5		not recorded
	6	128.0	234.0
30-197	0	38.2	456.3
	1	36.2	409.5
	2	45.2	386.1
	3	120.0	327.6
	4		Dead
30-215	0	37.0	514.8
	1	46.2	444.8
	2	53.6	427.1
	3	60.0	468.0
	4	86.0	384.0
	5	170.0	375.0
	6	300.0	350.0
	7		Dead

## MORTON AND PEARSE, JR.

30-168	0	39.8	464.9
	1	39.0	432.9
	2	40.0	386.1
	3	42.8	409.0
	4	46.6	374.4
	5	58.0	352.0
	6	80.0	385.0
	7	177.0	335.0
	8		Dead

*Discussion.*—A consideration of the results obtained in these experiments makes it seem likely that the clinical picture produced is indistinguishable in complete simple high obstruction and complete fistula at the same level. If there is a toxæmia present, which may still be argued on account of the rise in nonprotein nitrogen, it must equally be present in the two conditions. This makes it obvious that the obstruction *per se* is not the essential factor in producing the picture. The syndrome, both clinical and chemical, is associated with loss of the contents of the involved intestinal tract and not with their retention. Clairmont and Ranzi,<sup>2</sup> Braun and Borrutau,<sup>3</sup> and Enderlen and Hotz,<sup>4</sup> have all shown that absorption comes practically to a standstill in the loops of obstructed intestine. Consequently, in obstruction the contents of the distended loops of bowel and stomach may contain the essential material, but it cannot be used.

Much information is already available as to the importance of different constituents of the secretion of the upper gastro-intestinal tract. The investigations of Haden and Orr,<sup>5</sup> Gamble, *et al.*<sup>6</sup> and others have clearly established the importance of the sodium-chloride content. The total loss of gastric juice has been shown by Dragstedt and Ellis<sup>7</sup> to produce a similar condition with marked alkalosis. Elman<sup>8</sup> has deviated the pancreatic secretion so that it was no longer available with striking changes indicating the necessity for this material.

Werelius<sup>9</sup> contends that the danger stage in obstructions is reached when the bile is no longer secreted; and Brockman<sup>10</sup> has supplied bile per rectum successfully in the treatment of intestinal obstruction.

Experiments have been done by White and Fender,<sup>11</sup> Pearse<sup>12</sup> and others wherein the whole content of the obstructed segment of the gastro-intestinal tract which is normally lost in vomiting or stagnation in the loops is re-supplied so that it is made available for the animals. Under such conditions, all evidence of toxæmia disappears, and the general health remains normal for a considerable time. After long periods, a metabolic change of some kind occurs so that there is a loss of weight, loss of appetite and weakness noted.

Changes in the blood chemistry in duodenal fistulas were previously recorded by Walters, Kilgore and Bollmann.<sup>13</sup> Their work showed chemical changes in the blood which were strikingly similar to those noted in high obstructions. These investigators attached importance to the distension of the duodenum found in animals having a high intestinal fistula. In our

## RESULTS OF INTESTINAL OBSTRUCTION AND OF FISTULA

experiments a slight gaseous distension of the duodenum was observed at post-mortem examination, but no evidence of retention was found. This was considered a post-mortem change. The importance of preserving the contents of the obstructed loops has already been noted by Haden and Orr,<sup>14</sup> who claimed a more rapid death after enterostomy in their obstructed animals. It seems probable that there is still a limited field for the use of enterostomy in releasing the tension on the intestine, thus preventing strangulation. Excessive distension is more dangerous than is generally recognized, even though it has received considerable attention in experimental work (Van Zwalenburg,<sup>15</sup> Brooks, *et al.*,<sup>16</sup> Gatch, Trusler and Ayers,<sup>17</sup> Morton,<sup>18</sup> *etc.*). The duodenal tube for drainage is often successful for the same reason. A much safer method for a bad obstruction would seem to be an internal anastomosis between the obstructed and collapsed loops of bowel, diverting the contents around the obstruction and preserving the essential constituents. The writers have used this method successfully in a number of cases.

The correlation between simple obstruction and complete fistula at the same level is so remarkable that it is strange that there has been so little comment on the similarity. From evidence such as we have presented, it is necessary to assume that either there is a toxæmia present in both, or that there is no toxæmia in either. The search for the toxin has been conducted for so long, with such conflicting results, and with so little evidence that it exists anywhere in the body except in the loop contents, the preservation of which has proved to be so valuable, that it would seem more satisfactory to take the second alternative.

### CONCLUSIONS

(1) Simple high intestinal obstruction and complete fistula at the same level are essentially similar in clinical picture, blood-chemical changes, and life expectancy.

(2) Toxæmia must be present in both or not present in either.

(3) In any case, obstruction *per se* is not the important factor, for the picture is produced from loss of the contents of the obstructed bowel and not from their retention.

(4) The obstructed loop contents have been in the past the only available source for the supposed toxin. No one has demonstrated such a toxin in the blood or other tissues of the obstructed animals.

(5) It seems more reasonable to conclude, then, that there is no toxæmia in either simple high obstruction or complete fistula.

(6) The syndrome is due to a deficiency of essential secretions lost from the upper gastro-intestinal tract.

(7) This may come about by loss through vomiting, or by deficiency in absorption from the disturbed segment.

(8) Practically every case of intestinal obstruction should be regarded as a potential strangulation.

(9) Enterostomy, if too complete, may have a very deleterious effect on intestinal obstruction.

(10) Measures to preserve the loop contents, such as internal anastomosis, would seem to be more valuable.

## BIBLIOGRAPHY

- <sup>1</sup> Morton, J. J., and Stabins, S. J.: Relation of Bacillus Welchii Antitoxin to the Toxæmia of Intestinal Obstruction. *Arch. Surg.*, vol. xvii, p. 860, 1928.
- <sup>2</sup> Clairmont, P., and Ranzi, E.: Zur Frage der Autointoxication bei Ileus. *Arch. f. Klin. Chir.* vol. lxxiii, p. 696, 1904.
- <sup>3</sup> Braun, W., and Borrratau, H.: Experimental-Kritische Untersuchungen uber den Ileustod. *Deutsche Ztschr. f. Chir.*, vol. xcvi, p. 544, 1908.
- <sup>4</sup> Enderlen and Hotz: Ueber die Resorption bei Ileus and Peritonitis. *Mitt. a. d. Grenzgeb. der Med. u. Chir.*, vol. xxiii, p. 755, 1911.
- <sup>5</sup> Haden, R. L., and Orr, T. G.: The Effect of Sodium Chloride on the Chemical Changes in the Blood of the Dog After Pyloric and Intestinal Obstruction. *J. Exper. Med.*, vol. xxxviii, p. 55, 1923.
- <sup>6</sup> Gamble, J. D., and McIver, M. A.: Body Fluid Changes Due to Upper Intestinal Obstruction. *J.A.M.A.*, vol. xci, p. 1589, 1928.
- <sup>7</sup> Dragstedt, L. R., and Ellis, J. C.: The Fatal Effect of the Total Loss of Gastric Juice. *Am. J. Physiol.*, vol. xciii, p. 407, 1930.
- <sup>8</sup> Elman, R., and Hartmann, A. F.: The Cause of Death Following Rapidly the Total Loss of Pancreatic Juice. *Arch. Surg.*, vol. xx, p. 333, 1930.
- <sup>9</sup> Werelius, A.: Is Death in High Intestinal Obstruction Due to Liver Insufficiency? *J.A.M.A.*, vol. lxxix, p. 535, 1922.
- <sup>10</sup> Brockman, R. S.: Toxæmia of Acute Intestinal Obstruction. *Lancet*, vol. ii, p. 317, 1927.
- <sup>11</sup> White, J. C., and Fender, F. A.: The Cause of Death in Uncomplicated High Intestinal Obstruction. *Arch. Surg.*, vol. xx, p. 897, 1930.
- <sup>12</sup> Pearse, H. E., Jr.: Is Toxæmia the Cause of Death in Uncomplicated Intestinal Obstruction? *ANNALS OF SURGERY*, vol. xciii, p. 915, 1931.
- <sup>13</sup> Walters, W., Kilgore, A. M., and Bollmann, J. L.: Changes in the Blood Resulting from Duodenal Fistula. *J.A.M.A.*, vol. lxxxvi, p. 186, 1926.
- <sup>14</sup> Haden, R. L., and Orr, T. G.: Effect of Jejunostomy on Experimental Obstruction of the Jejunum of the Dog. *J. Exper. Med.*, vol. xliii, p. 483, 1926.
- <sup>15</sup> Van Zwalenburg, C.: Strangulation Resulting from Distention of Hollow Viscera, *ANNALS OF SURGERY*, vol. xlvi, p. 780, 1907.
- <sup>16</sup> Brooks, B., Schumacher, H. W., and Wattenberg, J. E.: Intestinal Obstruction: An Experimental Study. *ANNALS OF SURGERY*, vol. lxxvii, p. 210, 1918.
- <sup>17</sup> Gatch, W. D., Trusler, H. M., and Ayres, K. D.: Causes of Death in Acute Obstruction: Clinical Application and General Principles of Treatment. *Surg., Gynec., and Obst.*, vol. xlvi, p. 332, 1928.
- <sup>18</sup> Morton, J. J.: The Differences Between High and Low Intestinal Obstruction in the Dog. An Anatomic and Physiologic Explanation. *Arch. Surg.*, vol. xviii, p. 1119, 1929.