

INTESTINAL OBSTRUCTION IN THE RABBIT. II.*

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In an earlier paper¹ concerning intestinal obstruction in the rabbit, we have emphasized the fact that obstruction by ligature of the duodenum is more quickly fatal than obstruction of the pylorus or of the ileum. It was further stated as our belief that death in duodenal obstruction is due to the resorption of a toxic secretion of the duodenal mucosa, a secretion which is rapidly poured out into the lumen of the intestine after obstruction and was shown to produce fatal results in healthy rabbits if injected intraperitoneally in appropriate amounts. The explanation for the delayed death in low obstruction, it was suggested, might lie in the theory of Draper that for a time, at least, this duodenal secretion is neutralized by the secretion of the mucosa of the ileum and jejunum. By offering such an explanation we intimated as our tentative belief that in both high and low obstruction of the small intestine the cause of death lay in this toxic duodenal secretion. While this was not directly stated, it was our belief that this was the fact, except in those cases in which bacterial invasion of the injured mucosa and of the peritoneum could be demonstrated.

Before such a theory could be established, the toxicity of the secretion from isolated loops of the ileum and jejunum must be compared with that from the duodenum. Even in fasting animals, the duodenal secretion is poured out rapidly and apparently continuously, so that within four or five hours after obstruction, the duodenum above the lower ligature is tense with a clear, slightly straw colored, mucin-containing, alkaline solution. At this time, one obtains about one cubic centimeter of fluid per each linear centimeter of the obstructed loop. To determine whether a similar

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¹ Bunting, C. H., and Jones, A. P., *Jour. Exper. Med.*, 1913, xvii, 192.

phenomenon occurred lower down in the small intestine, a small series of fasting animals was operated upon. Loops of intestine of sufficient length to avoid the danger of strangulation were isolated by obstructing the lumen at either end by coarse, soft ligatures, applied so as to do the least possible injury to mucosa and blood vessels.

In two animals (rabbits 92 and 93 of the series) such loops of the ileum were made under ether anesthesia after the animals had fasted thirty-six hours. In rabbit 92 the lower ligature was placed just above the ileocecal juncture; the upper, thirty-four centimeters above. In rabbit 93 the lower ligature was similarly placed, and the upper was twenty-eight centimeters above. Four hours after the first operation, the animals were again etherized, the abdomen was opened, and the condition of the intestine noted. In both cases the isolated portion of the intestine was found to be flat and empty. The duodenum, however, was well filled with fluid which had begun to flow downward into the jejunum. Both animals died between thirty-six and forty-eight hours after the primary operation, and in both the post-mortem examination showed the intestine above the upper ligature well filled with secretion, but the section between the ligatures was as empty of fluid as at the time of operation. There had been no secretion into it.

In two other animals (rabbits 94 and 95), with similar treatment and technique, jejunal loops instead of ileal were isolated. In rabbit 94 a loop twenty-six centimeters in length, with the upper ligature fifty-six centimeters from the pylorus, was tied off. In rabbit 95 the upper ligature was placed thirty-two centimeters from the pylorus, just beyond the entrance of the pancreatic duct, while the second was placed forty-five centimeters further down. Rabbit 94 was subjected to a second operation four hours later, and it was found that the duodenum was becoming tense with fluid, while the segment between the ligatures was flat. At autopsy on the two animals the same condition was found as in the animals with ileal loops. There was no secretion whatever into the jejunum, but the duodenal segment above was tense with fluid.

It seemed probable from the two sets of animals, that in the fasting rabbit the duodenum is the only part of the small intestine

which secretes actively into the lumen. It was necessary, however, to meet the objection that peristaltic waves from above, or gastric or hepatic secretion, might stimulate the duodenal mucosa to secretion, while the upper ligature prevented the passage of such stimuli to the lower segment, and thus inhibited secretion. The rabbit is a favorable animal for the determination of this point, because of the length of its duodenum, which may be held to extend to the entrance of the pancreatic duct, a distance of from twenty-five to thirty centimeters from the pylorus.

In rabbit 96, therefore, at the first operation a series of ligatures was placed about the intestine. The first was seven centimeters below the pylorus; the second was at the entrance of the pancreatic duct, and so tied as to occlude both the duct and the intestine. The third ligature was placed twenty-one centimeters further down, the fourth thirty-two centimeters, the fifth thirty-eight centimeters, and the sixth thirty-eight centimeters further. Four hours after operation the first loop was tense with secretion, the second well filled, and all others empty. At autopsy, within twenty-four hours after the operation, the same condition was found, the secretion stopping short at the ligature at the pancreatic duct level.

In rabbit 105 the same procedure was employed, with the exception that the first ligature occluded the pylorus and bile duct, the second was ten centimeters below this, the third was so tied as to occlude pancreatic duct and intestine, and the lower ligatures were spaced at a distance of about fifteen centimeters. At the post-mortem examination, twenty hours after the operation, the two duodenal loops were found widely distended with fluid, while all the others were flat and empty.

It is evident from this that a tight ligature placed about the duodenum does not interfere with the secretion by the segment below the ligature, and we seem justified then in our conclusion that in the fasting rabbit the only section of the small intestine which secretes into the lumen is that lying between the pylorus and the entrance of the pancreatic duct.

This upper segment of the small intestine apparently differs from that lying immediately below the entrance of the pancreatic duct in but one particular,—the presence of the glands of Brünner.

In the rabbit, as shown by section of several duodena, these glands are distributed for a distance of from twenty-five to thirty centimeters from the pylorus, a distance quite coincident with the actively secreting part of the intestine, as shown by our experiments. Consequently it seems justifiable to conclude that the glands of Brünner furnish the secretion we have found in these cases.

As our experiments have been conducted only on the rabbit, the evidence offered can at present be applied only to that species of animal. But from this series, as well as from other experiments, the results of which were reported in the earlier paper, we feel assured that in the fasting rabbit the duodenal mucosa alone secretes, that this secretion comes from the glands of Brünner, and, being toxic, is responsible for the death of the animal with obstruction of the small intestine, at whatever level the obstruction be made.