
By ERNEST G. GREY, M.D.
(From the Surgical Division of the Hunterian Laboratory of the Johns Hopkins University, Baltimore.)

(Received for publication, July 9, 1917.)

Recent work has shown the important part played by the alkaline duodenal contents, the pancreatic juice in particular, in the maintenance of a uniform level of gastric acidity. While the presence of bile and pancreatic juice in the stomach was noted a number of years ago by Boss, it remained for Boldyreff (1907-08, 1911) to demonstrate experimentally that a regurgitation of duodenal juices, after the ingestion of certain foodstuffs, is of such regular occurrence that the process may be regarded as an accompaniment of normal gastric digestion. Confirmatory evidence for the existence of the mechanism responsible for this regurgitation has since been offered by Carlson (1915, b) Hicks and Visher, Zaitseff, Spencer, Meyer, Rehfuss, and Hawk, Morse, and others.

It has been demonstrated, furthermore, that neutral, alkaline, or feebly acid fluids provoke a secretion of acid juice in order that the gastric acidity may be brought to the normal level. The experiments of Lönnqvist, for example, have shown that when weak soda solutions (0.25 to 0.5 per cent) are introduced into the stomach they act like water in causing a secretion of gastric juice. With stronger concentrations (1.0 to 1.5 per cent) the amount of secretion is materially increased. While it is not inconceivable that strong alkaline solutions, acting as an irritant to the duodenal mucosa, may lead, indirectly, to an outpouring of acid in the stomach, it is not likely that the weaker solutions act upon the gastric glands in this way. In fact Lönnqvist found that when solutions of soda were placed in the duodenum they led to a slightly diminished secretion of gastric juice.

There is but little evidence, however, to show how the level of gastric acidity is affected when alkaline solutions are introduced into the stomach, more or less continuously throughout the period of digestion. In view of the findings of Boldyreff (1911) which indicate that the gastric contents become more acid (hyper-acidity) when there is an insufficient regurgitation of duodenal juices, one might expect to find a lowered level of acidity in the presence of an excessive duodenal regurgitation. When fats are fed in considerable amounts they bring about
a profuse influx of duodenal contents into the stomach, and at these times there is a decrease in the acidity level. But, as fat is only slightly affected by gastric juice, these experiments merely serve to demonstrate how the duodenum may aid the stomach in its struggle with an unusual burden.

While it would be difficult, experimentally, to increase or prolong the duodenal regurgitation without introducing fat or strongly acid solutions into the stomach, evidence bearing on this problem may be obtained by preparing animals in such a way that an unusual amount of bile or pancreatic juice enters the stomach throughout the period of digestion. In an earlier report (Grey) experiments were cited in which the total output of bile was made to flow through the stomach in its passage to the intestines. The present communication concerns certain additional experiments in which the pancreatic juice was diverted from the duodenum into the stomach.

The results of the first investigation appeared to indicate that the presence in the stomach throughout the course of digestion of the entire output of bile does not materially affect the level of gastric acidity. While no interpretation of these findings was attempted in the published report of the experiments, it was apparent, nevertheless, that they did not necessarily imply that bile is a feeble, neutralizing agent, but suggested, rather, that there had been a compensatory increase in the secretion of hydrochloric acid whereby an approximately normal level of acidity was maintained.

The analysis of the pure juice obtained from the smaller (Pawlow) stomachs did not reveal any appreciable changes in the hydrochloric acid content of the secretion secured subsequent to the introduction of bile. This observation was in accord with the findings of Carlson (1915, b) which point to a constant and uniform acidity of the digestion juice when it is secreted at a fairly high rate. A uniformly lower acidity is found under other circumstances; i.e., in the empty stomach and in the continuous or hunger secretion, when the secretion rate is low.

The protocols of these experiments, however, indicate that there was a definite increase in the quantity of the digestive juice secreted after the bile had been diverted into the stomach. This conclusion has been based upon a comparison of the average of between twenty-five and thirty measurements made previous to the anastomosis with a similar average of a like number of measurements carried out subsequent to the operation. Inasmuch as there is some variation both in the quantity and in the acidity of the specimens secured from day to day under approximately constant conditions, it is not feasible to compare the data from any two single observations. The figures taken from the protocol of Dog 2 and published in Table I of the report under discussion were chosen because they furnished an accurate picture of the average acidity values, before and after the anastomoses. They indicate, however, differences only of about 7½ per cent in the two outputs. In this respect the table was misleading since a comparison of the average amounts of juice secreted before and after the anastomoses revealed a considerably greater difference than this.
It was obviously impossible to make quantitative studies of the hydrochloric acid output in the animals in which samples of the gastric contents were analyzed—apomorphine experiments. But since no material change in the acidity level was noted after the introduction of the bile, it seems justifiable to infer that a compensatory increase in the gastric secretion had ensued to counterbalance the unusual quantity of alkaline fluid in the stomach.

Analyses of the secretions of the upper intestinal tract have shown that a number of them are capable of neutralizing more or less acid in the gastric juice; i.e., saliva, gastric mucus, pyloric juice, the secretion of Brunner's glands, succus entericus, bile, and the pancreatic juice. Of these the pancreatic juice is by far the most important, since the alkalinity of this secretion is half again as great as that of all the other secretions combined (Boldyreff, 1914–15).

Because of the marked alkalinity of the pancreatic juice and in view of the results obtained from the bile experiments, it seemed important to study the effects on the level of gastric acidity of an increased supply of pancreatic juice in the stomach. In the experiments to be cited the larger pancreatic duct of each animal was transplanted into the wall of the stomach and the lesser duct ligated and divided.

This procedure afforded an opportunity to make certain additional observations. It has been the view of some workers that the hydrochloric acid in the duodenum is responsible for certain of the pathological changes which are found in the pancreas. Hlava, for example, suggested that by antiperistalsis hyperacid gastric juice may be forced from the intestine into the pancreatic duct, thus causing hemorrhagic pancreatitis. If this postulation is valid in any sense, then an experimental procedure such as that mentioned should afford a favorable opportunity for the gastric juice to reach the gland and set up acute inflammatory or chronic sclerotic changes.

Flexner injected hydrochloric acid solutions ranging in strength from 0.5 to 2 per cent into the pancreas and through its duct and subsequently observed profound changes in the organ corresponding in degree to the amount of acid used. The pathological picture was that of hemorrhagic pancreatitis. However, though these studies demonstrated that hydrochloric acid, as well as certain other agents, is capable of producing an acute inflammatory degeneration, Flexner did not offer his results as evidence confirming the hypothesis of Hlava.
Dr. Halsted's instructive case of stone in the ampulla of Vater and Opie's experiments have shown the great significance of one of the duodenal juices—bile—in pancreatic diseases. But the manner of entry of the bile into the pancreatic duct in these instances is essentially different from that suggested by Hlava. In Opie's opinion there is no satisfactory proof to indicate that the hydrochloric acid is instrumental in bringing about such a disease.

Methods.

The present report is based upon the results obtained from experiments carried out on seven dogs. A number of additional animals were used in the early part of the work, but they were employed solely in solving the surgical aspects of the problem.

Inasmuch as the principal purpose of the investigation was to follow the changes in the acidity level of the stomach, it seemed best to analyze specimens of the test meals instead of studying the pure gastric juice as was done in some of the bile experiments referred to above. For this purpose the gastric fistula as devised by Janeway proved to be satisfactory. All the animals were anesthetized with ether.

A small three-sided piece of stomach wall was turned down toward the greater curvature. This constituted a rectangular flap with its blood supply intact. By sewing the lateral margins together and closing the opening in the gastric wall a small tube was formed which was lined throughout by mucous membrane. The distal end was then sewed into the abdominal wall, care being taken to anchor it to the peritoneum, fascia, and skin. The mucosa and skin, of course, were sutured together. In experimenting with the reconstruction a very important feature was noted. During the first weeks subsequent to the operation there is a marked retraction of the new tube toward the peritoneal cavity, with a definite contraction of the external opening. The effects of these changes, however, may be greatly minimized if care is exercised during the operative procedure to anchor the tube in the abdominal parietes so that it protrudes for several centimeters above the level of the skin. This may be done without embarrassing the blood supply. It leaves a wide cuff of gastric mucosa exposed on the surface. When the skin margins are loosely attached to the latter, a considerable contraction of the opening may
take place without in any way stenosing the canal. Fistulas constructed on this plan will remain patent for many months. Frequent catheterization with only the most gentle manipulations serves to keep the tract clean.

Inspection of one of these fistulas 3 or 4 months subsequent to its construction shows a lead-pencil-like tube, 4 or 5 cm. in length, extending through the peritoneal cavity from the abdominal wall to the stomach. This arrangement probably interferes but little with the normal gastric movements. After the heartiest meal and even during emesis there is no loss of stomach contents from the canal.

While the experiments are still in progress concerning the transplantation of the pancreatic duct, devoid of duodenum, into the stomach wall, no satisfactory results of this nature were secured during the course of the work reported here. However, it was found possible to resect a very short cylinder of duodenum, approximately 2 cm. in length, containing the orifice of the major pancreatic duct, and, after closing one end, to transplant the opposite opening into the posterior wall of the stomach. Since this segment of small bowel devoid of its blood supply may atrophy and lead, as one of the earliest specimens demonstrated, to a stenosis of the duct, it was found necessary always to preserve the vessels of the transplanted duodenum. When care is exercised this may be accomplished without great difficulty. An end to end anastomosis then established the continuity of the duodenum. The lesser pancreatic duct which opens into the duodenum together with the common bile duct was now identified by dissection, doubly ligated, and divided.

While the transplantation of the pancreatic duct leads to a displacement of the adjoining parts of the pancreas, the new arrangement does not cause undue tension on the vessels which supply this organ. The operation is readily carried out through a high right rectus or midline incision.

A standard mixture of 70 gm. of ground, raw, lean beef and 75 cc. of tap water was used as a test meal. Samples were withdrawn for analysis 2 and 3 hours after the ingestion of the meal. These periods were chosen for two reasons. In the first place, it was found that at shorter intervals following the ingestion of the test meals the food had not undergone sufficient digestion; and after longer intervals
it was frequently very difficult to secure specimens for analysis, the ingesta apparently having left the stomach in large part. In the second place, it has been shown (Carlson, 1915, a) that the quantity of gastric juice yielded by a dog's accessory stomach (Pawlow) during the first 2 hours on a moderate meal of meat is about one-half that secreted for the entire digestive period. And from McClendon's experiments on man it appears that the acidity of the adult stomach rises during the first 1½ to 3 hours subsequent to a meal, after which it remains stationary until the food has nearly all left the stomach.

Care was taken to conduct the observations in the forenoon 18 hours after the last meal. The dogs received the same diet each day. Water was withdrawn after the test meals had been given. But throughout the balance of the day the animals were permitted to take as much water as they desired. The amount of exercise, the quantity of food, and the environmental conditions remained constant throughout the weeks of study.

Several dozen test meals were given in each case. The average results obtained under these conditions were taken to represent fairly accurately the normal acidity of the chyme. In withdrawing samples for analyses care was exercised to discard the contents of the fistula itself. The end of a soft rubber catheter gently introduced a few centimeters into the stomach cavity was connected with a stoppered flask. Attached to one arm of the latter was a large syringe. The suction created by withdrawing the plunger usually resulted in a discharge of sufficient juice for study.

For the quantitative estimation of trypsin in the gastric contents Spencer's modification of the Ehrenreich test was used.

The acidity determinations were made by titrating 1 cc. of the sample against \( \frac{1}{10} \) sodium hydroxide, using dimethylaminoozobenzene and phenolphthalein as indicators. The values have been expressed as the number of cubic centimeters of 0.1 N sodium hydroxide necessary to neutralize 100 cc. of gastric contents.

RESULTS.

Early in the course of the work it was noted that when test meals were given to the same animal on different days, under conditions
as similar as possible, samples of the gastric contents showed considerable variation in the hydrochloric acid content. Corresponding observations had been made during the course of the bile experiments discussed above. It was necessary, accordingly, to repeat the analyses a great number of times and average the results in order to secure an accurate picture of the acidity level at the periods of digestion chosen; i.e., 2 and 3 hours after the ingestion of the meal. This mean was established both before and after the transplantation of the duct for each animal.

**TABLE I.**

<table>
<thead>
<tr>
<th>Dog No.</th>
<th>Before transplantation of the duct.</th>
<th>After transplantation of the duct.</th>
<th>Interval between the fistula operation and the transplantation.</th>
<th>Interval between the transplantation and the first analysis.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 hrs.</td>
<td>3 hrs.</td>
<td>2 hrs.</td>
<td>3 hrs.</td>
</tr>
<tr>
<td>1*</td>
<td>104†</td>
<td>93</td>
<td>113</td>
<td>67</td>
</tr>
<tr>
<td>2*</td>
<td>107</td>
<td>100</td>
<td>122</td>
<td>74</td>
</tr>
<tr>
<td>3*</td>
<td>108</td>
<td>122</td>
<td>125</td>
<td>98</td>
</tr>
<tr>
<td>4*</td>
<td>103</td>
<td>115</td>
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<td>57</td>
</tr>
<tr>
<td>6*</td>
<td>96</td>
<td>82</td>
<td>91</td>
<td>67</td>
</tr>
<tr>
<td>7†</td>
<td>112</td>
<td>120</td>
<td>108</td>
<td>73</td>
</tr>
</tbody>
</table>

* Test meal: 70 gm. of meat plus 75 cc. of water.
† Acidity values are expressed as the number of cubic centimeters of 0.1 N sodium hydroxide necessary to neutralize 100 cc. of gastric contents.
‡ Test meal: 100 gm. of meat plus 70 cc. of water.

In Table I the acidity values for each dog represent the average of the figures obtained in from ten to thirty separate analyses. The necessity for this mean has been emphasized by Foster and Lambert who believe that limitations of variability must be computed for each animal experimented upon, and that the only idea of limitation of function that we can gain must depend upon an average computed from the data for a number of animals. In the paper of Long and Hull the tables indicate a similar variation of the acid content from day to day.

In order to ascertain whether any relation might exist between the level of gastric acidity and the interval of time elapsing from the date
of the operative procedure to that of the analyses, the time factor was changed throughout the experiments. Though the animals were studied over varying periods, from 100 (Dog 5) to 228 days (Dog 7), no such relation was discernible.

From a study of the figures in the table it is evident that in three animals (Dogs 5, 6, and 7) the acidity level of the gastric contents was lowered by the introduction of pancreatic juice into the stomach, both at the 2 hour and at the 3 hour period of digestion. In Dog 7 the reduction was especially marked during the second period. On the other hand, the analyses in four of the animals (Nos. 1, 2, 3, and 4) showed a slight increase of acid in the 2 hour specimen, but a decrease in the specimens secured at the 3 hour period. While four of the seven dogs were thus found to have a higher level of gastric acidity subsequent to the transplantation of the pancreatic duct at the 2 hour period, it is noteworthy that in all the animals the acidity level fell at the 3 hour period. Moreover, in each of the latter, following the transplantation of the duct, the percentage of hydrochloric acid in the stomach contents was less at the 3 hour period than it was previous to the operation at the 2 hour period.

A further analysis of the table shows that in three dogs (Nos. 3, 4, and 7) before the pancreas had been disturbed, specimens of test meal contained more acid 3 hours after the ingestion of the food than an hour earlier than this; whereas the relationship was reversed in the remaining animals. These findings probably have their explanation in the fact that the dogs varied in size. In the smaller animals the process of gastric digestion was more prolonged. Subsequent to the operations, however, the specimen secured in the second period of digestion, in every case, contained less acid than that withdrawn during the first period. The constancy of this finding we may fairly attribute to the altered chemical conditions in the stomach induced by the pancreatic juice.

The experiments as a whole thus appear to indicate that the presence of a large quantity of pancreatic juice in the stomach throughout the period of digestion leads to a moderate reduction of the acidity level in the later stages of digestion. Earlier in the process there is no constant alteration of the acid content in either direction. The surprising feature of these results would seem to be the maintenance
of a relatively high acidity level in the presence of the large amount of pancreatic juice.

In view of the part played by the pancreatic juice in the self-regulating mechanism described by Boldyreff one might have anticipated, under these circumstances, a material reduction in the acidity level. The absence of such a result, however, is really in keeping with Boldyreff's hypothesis.

One of the controlling factors in the mechanism is the mucosa of the duodenum. Hyperacid stomach contents reaching this part of the digestive tract irritate the mucous membrane, and the latter, in turn, serves to bring about a reduction of the acidity level of the stomach through a regurgitation of alkaline duodenal juices. This type of self regulation, however, ensues only when the hydrochloric acid content of the chyme is above normal. When alkaline materials have lowered the acidity level a different process is called into action.

Experiments have shown that following the introduction of alkaline solutions into the stomach the gastric glands respond with a discharge of juice in an endeavor, it would appear, to restore the gastric acidity to the normal level. The presence of a considerable quantity of pancreatic juice in the stomach, of course, leads to a similar disturbance of the acidity level. Accordingly under these circumstances one would also expect to find an increase in the gastric secretion. Now it has been shown (Table I) that a more or less continuous influx of pancreatic juice into the stomach throughout the period of gastric digestion only depresses the acidity level in the later stages of digestion. This we can explain only by assuming that in the experiments mentioned there was an augmented secretion of hydrochloric acid throughout the digestive cycle corresponding to the continuous influx of alkaline fluid from the pancreas. These quantitative changes in the outflow of the juice were observed in certain of the bile experiments, referred to above.

In the work hitherto reported the activity of the stomach, as far as it concerns this phase of the self-regulating mechanism, has only been followed by the introduction into the stomach of a given quantity of some alkaline solution. These experiments, however, afford us an opportunity to watch the reactions of the stomach to alkaline material repeatedly administered throughout the digestive cycle.
The results obtained serve to draw attention to the remarkable capacity of the stomach to maintain a relatively high acidity of its contents. In the past perhaps undue emphasis has been laid on the occurrence of duodenal regurgitation. We shall probably be more exact in our conception of the mechanism which controls the level of gastric acidity when we constantly bear in mind that it, in turn, depends upon two more or less distinct, subsidiary mechanisms. One of these concerns the neutralization of hyperacid chyme through duodenal regurgitation. The other, a gastric process, provides for an outpouring of gastric juice when the stomach contents are below the normal acidity.

These findings have more or less clinical significance since it is not at all certain, at present, how much of the favorable results obtained from the medical treatment of gastric ulcer is due to a lowering of the acidity level. Carlson (1917) suggests that the relief from pain following the administration of alkalis or following gastroenterostomy may be due to other factors than the effect on the gastric juice. These factors may also explain, in part, the excellent results observed after the Finney pyloroplasty since this operation affords ideal conditions for the entrance of duodenal juices into the stomach.

The possibility, of course, must be borne in mind that subsequent to the transplantation of the duct into the stomach wall, the pancreas may have ceased discharging juice. Against this assumption, however, there is more or less conclusive evidence. In the first place, the results from the analyses indicate that there was a slight depression of the acidity level at the 3 hour period of digestion after transplantation of the duct, a finding to which there was no exception among the seven animals used. This pointed to an alteration in the chemistry of the stomach. In the second place, histological study of the parts of the pancreas adjacent to the large duct disclosed no discernible pathological changes such as would be expected were the duct occluded. In Hess' experience ligation of the ducts of the pancreas leads to a sclerosis of the entire gland. The amount of sclerosis is proportional to the size of the duct which has been ligated, together with the number of its communications. What is more, special stains demonstrated that the cells in this neighborhood were charged with secretion granules and, accordingly, that they were in an active
state. In the third place, the results obtained from the trypsin
determinations pointed toward the presence of an unusual quantity
of pancreatic juice in the stomach subsequent to the transference of
the duct from the duodenum to the stomach. And, finally, dissection
of the specimens removed at necropsy showed in each instance a
patent duct opening into the small duodenal transplant, with a
spacious communication between the latter and the stomach. In
one animal the postmortem examination was made about 120 days
subsequent to the operation on the pancreas.

The most convincing evidence that pancreatic juice is regularly
discharged into the stomach after this plastic operation is afforded
by the results which have been obtained in some more recent experi-
ments concerning duodenal extirpation. While this work is still
incomplete it has nevertheless shown that in duodenectomized animals
where the major pancreatic duct has been transplanted into the
gastric wall the pancreas remains histologically normal at the end of
the 5th week. For reasons which will be discussed in a subsequent
communication these animals have succumbed at about the end of
that period. The fact, however, that no changes of an atrophic
nature were ever discovered in the pancreas at postmortem examina-
tion, together with the invariable finding of a definite gastritis, furnish
reliable evidence that the pancreas continued to discharge its external
secretion into the digestive tract through its new communication
with the stomach.

Making use of a modification of Ehrenreich's test, Spencer, Meyer,
Rehfuss, and Hawk studied the trypsin values of the gastric contents
in man under varying conditions. The results of their experiments
serve to substantiate the regurgitation hypothesis of Boldyreff, and
indicate that tryptic digestion frequently proceeds in the normal
stomach. In view of this work an attempt was made to follow the
trypsin values of the stomach contents from two dogs (Nos. 3 and 7)
both previous and subsequent to the operation on the pancreas. The
test was repeated a considerable number of times with each animal.

Practically no digestion was ever noted in the tests carried out on
normal animals. Following the transplantation of the major pan-
creatic duct into the stomach, however, there was a definite digestion
of casein. A certain variation in the tryptic activity of the gastric
contents was appreciable from day to day, but this did not serve to obscure the difference referred to.

The new conditions established by the transplantation of the duct probably led to definite changes in the rate and character of digestion, both in the stomach and in the duodenum. Many believe that gastric juice is peculiarly destructive to the pancreatic ferment by virtue of the action of hydrochloric acid on the enzyme. As Long and Hull have shown, however, this may not actually be the case. Some tryptic digestion may occur within the stomach provided the free acid remains sufficiently low through protein combinations. Interesting as this aspect of the problem is, no further observations concerning digestion were carried out.

The animals were kept under observation for varying periods. Dog 7 was killed 121 days subsequent to the transplantation of the pancreatic duct. At that time it was in perfect health, having weaned a litter of well nourished pups a few days previously. In the series of seven dogs there was one death (Dog 1). This animal was active and appeared to be in good condition up to a few days before it died. At autopsy no satisfactory cause of death was discovered. There were many intestinal worms, but, as most of the laboratory animals harbor parasites of this nature, the findings may have no practical significance. Of the remaining five animals three were moderately well nourished and two rather undernourished when they were killed. All of them, however, ate heartily of their food.

Postmortem examination revealed an interesting condition at the site of the transplantation. In each animal there was a tiny pouch of duodenum attached to the stomach. The line of demarcation between the two was clearly evident, and as far as the macroscopic features were concerned, there was little to differentiate the transplant from the neighboring duodenum. It retained some, if not all, of its original blood supply.

The major pancreatic duct was readily found opening into the base of the pouch. Inspection of the wall showed it to be soft and of normal caliber, and on instrumentation the duct admitted a relatively large probe. There were no signs of atresia of the duct in any of the seven specimens examined. A search was made in each case for any possible accessory communications between the gland and the duo-
denum. We know from the studies of Hess on the canine pancreas that there may be three and occasionally four ducts opening into the duodenum. The main duct which arises from the union of two large branches drains the principal canal system of the pancreas. The accessory duct lies more oralward and opens into the intestinal lumen in association with the ductus choledochus. Between the two lies a smaller communicating channel. A fourth duct may connect the pars descendens with the duodenum.

In none of the specimens was the accessory duct found. But the search was not complete in any case since it was necessary to preserve the structures for histological study. In two of the seven animals a very small communication was found opening into the duodenum just proximal to the site of the end to end anastomosis. If a third duct of this type had been present in the other animals it seemed probable at the time of the necropsies that it had been destroyed in the course of the transplantations and the anastomoses.

The observations which have since been made on the duodenectomized animals, however, indicate clearly that some accessory communication between the pancreas and the intestine must have existed in each dog of the series, since the discharge into the stomach of the total output of pancreatic juice leads to profound changes in nutrition and to the development of a definite gastritis, and evidences of these processes were never discovered in any of the animals under discussion.

In gross the pancreas seemed normal in every way except that it gave the impression of being somewhat smaller than usual. The mucosa of the duodenal transplant, of the stomach, and of the intestine throughout its length showed no signs of ulceration or sclerotic changes. There was no injection even in the vicinity of the pancreatic duct. Lönnqvist has reported a temporary catarrhal condition of the gastric mucous membrane following a profuse reflux of bile and pancreatic juice into the stomach. There was nothing, however, either in the anatomical findings or in the characteristics of the samples of test meal removed to suggest this condition in any of these animals. But the experiences with duodenectomized animals have since demonstrated that pathological changes make their
appearance in the stomach as soon as the total quantity of the pancreatic secretion is diverted into the viscus.

Histological study of the pancreas disclosed no inflammatory or degenerative changes. It should be emphasized, nevertheless, that sections were prepared only from the central portions of the gland. Had the tissue adjoining the lesser duct been studied it is possible that the examination might have revealed some atrophic changes. In four of the specimens sections were prepared with the acid fuchsin-methylene green stain of Bensley. With this technique the cells were seen to be filled with secretion granules. The preparations examined were considered to represent normal tissue.¹

The urine of one animal was followed for a number of weeks subsequent to the second operation (transplantation of the pancreatic duct). While some reducing substances were occasionally encountered the findings at no time suggested the presence of sugar.

SUMMARY AND CONCLUSIONS.

The mechanism described for maintaining the optimum level of gastric acidity is designated by Boldyreff as the “self regulation of the acidity of the contents of the stomach.” In support of Boldyreff’s hypothesis is the evidence obtained from many experiments carried out both on man and on animals, in which solutions of alkali and acid have been placed in the stomach. The introduction of acid fluid has led to a regurgitation of alkaline duodenal contents, whereas the introduction of alkaline solutions has called forth a secretion of acid gastric juice.

The experiments reported in this paper were carried out for the purpose of ascertaining how the stomach would react, in as far as the secretion of hydrochloric acid is concerned, to a more or less continuous influx of relatively strong alkaline fluid, prolonged throughout the cycle of digestion. Numerous studies have shown that any serious interference with the process of regurgitation leads to a rise in the acidity level of the stomach; i.e., to a state of hyperacidity. There is but little evidence, however, to indicate whether the acidity level will be depressed temporarily or permanently (hypoacidity)

¹ Dr. E. Goetsch examined these preparations.
when alkaline material, in considerable amounts, continues to enter the stomach.

The influx of alkaline fluid was provided for by transplanting the larger pancreatic duct into the wall of the stomach after ligating and dividing the lesser duct. Specimens of test meal for analysis were withdrawn through gastric fistulas made after the method of Janeway.

Animals prepared in this manner served also to furnish additional information regarding the possible relation of the hydrochloric acid of the gastric juice to certain acute inflammatory and chronic sclerotic changes in the pancreas.

From the results of these experiments it appears that the presence of a considerable amount of pancreatic juice in the stomach throughout the period of digestion leads only to a moderate decrease in the acidity level of the ingesta in the later stages of digestion. Earlier in the process there is no constant alteration of the acidity level in either direction. The findings then serve not only to corroborate the views of Boldyreff, but also to demonstrate the remarkable compensatory activity of the gastric glands under conditions which entail an unusual quantity of alkali in the stomach.

In addition the work has shown that when the larger pancreatic duct is properly transplanted into the wall of the stomach, it may remain patent for months. In animals in which this operative procedure has been carried out, the pancreas has been found to undergo no inflammatory or other degenerative changes. This finding is regarded as evidence against the postulation of Hlava that gastric juice is probably responsible for the occurrence of certain cases of acute hemorrhagic pancreatitis.

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