

THE EFFECT OF VITAMIN (B) AND (C) DEFICIENCY ON THE MECHANICS OF THE INTESTINAL TRACT.

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An experiment was conducted in order to determine whether deficiency diets materially affect the motility of the intestinal tract in beriberi rats and in scurvey guinea pigs.

There is according to Alvarez (1922) a definite rhythmic gradient in the intestine from pylorus to colon, the rate of rhythmic contraction varying from seventeen to twenty per minute in the duodenum to ten per minute in the lower ileum while the larger bowel is more sluggish than the small intestine.

The method of isolated strips as described by Alvarez (1922) was used in this experiment and comparisons of the normal with the experimental segments were made in rate of and amplitude of rhythmic contractions, tonus and duration, or the length of time during which the excised strips exhibit spontaneous contractions in oxygenated Locke's solution.

After decapitation the abdomen of the animal was quickly opened. A loop of intestine two and one half centimeters long was removed from the duodenum immediately below the stomach, the same length of terminal ileum and a similar portion of the colon about thirty millimeters above the anus. The remainder of the tract (with the exception of the caecum) was put into Petri dishes and placed on ice where the temperature registered from one degree to five degrees Centigrade.

The three isolated strips were suspended in a dish containing exactly one liter of oxygenated Locke's solution kept at a constant temperature of 38°C by means of a pencil thermostat. The oxygen was liberated through a glass cannula which was fastened to the bottom of the dish and the bubbles passed through the solution at the rate of ten per minute. Levers were arranged which recorded the rhythmic contractions and tonus on a kymographic paper. The leverage, length of arm, and load were not changed

throughout the course of the experiment so that the work and magnification were comparable. Preparations of both the normal and experimental animals were made in this manner and tracings were run from the refrigerated strips on the second, third and fourth days after removal from the animal. The normal animals were starved for forty-eight hours previous to the experiment to insure an empty alimentary canal.

Twenty-four rats were given B free diet. The ration consisted of casein (18) grams, starch (54) grams, lard (15) grams, butter fat (9) grams, and salts (4) grams. (Osborne & Mendel). The average time on this diet was seven weeks during which there was a gradual loss in weight and in general a marasmic condition. The number of feces decreased which seemed indicative of constipation. Five of the experimental animals developed a spastic gate at which stage they were killed for the experiment. Seven normal animals were used for controls.

As shown in Chart I the normal duodenums lived 148 minutes longer than the beriberi duodenums, the normal ileum 173 longer than the beriberi ileum while the normal colon exceeded the beriberi colon by 467 minutes. In every case tracings from strips of the intestine on ice were run on the second day; but not one of the beriberi segments showed motility on the second day while six of the normal duodenums were active, one of the normal ileums and seven of the normal colons.

The contraction rate was calculated for the first and third hours—Chart II. Both the normal and experimental duodenums contracted the first hour at the same rate, but the (B) deficient duodenums lost rapidly so that at the end of the third hour the normal was giving almost double the number of contractions. Even the first hour the beriberi ileum showed a decidedly lower rate than the normal and at the end of the third hour the beriberi ileum dropped to the zero point while the normal ileum was able to give 268 contractions. The two colons kept pace with only a difference of eight contractions in favor of the normal at the end of the third hour.

Chart III—The tonus factor showed a great variation in the number of waves, especially in the normal ileum and colon. In the duodenum the first hour, there were on the

average only two more waves, in the ileum 19, in the colon 16.

In the case of the ileum, the amplitude of the rhythmic tonus contractions averaged higher in the normal than in the beriberi strips. This was also true for the duodenum and the colon but here the difference in favor of the normals was less marked.

Excised intestinal segments of the beriberi rat showed no spontaneous contractions or tone after twenty-four hours on ice. Therefore, the endurance of the intestinal motor mechanism is doubtlessly impaired in Vitamin (B) deficiency since in every experiment the normal strips were active on the second day. Absence of Vitamin (B) from the diet of a rat diminished the length of time during which an excised strip exhibits spontaneous contractions in oxygenated Locke's solution. The amplitude and rate of the rhythmic contraction is markedly decreased in the spastic stage of the beriberi rat especially in the duodenal and ilial segments.

The same method was employed for testing the mechanics of the intestinal tracts in acute scurvy. Ten normal guinea pigs and nine scorbutic animals were used in the experiment.

The experimental guinea pigs were fed C free diet composed of oats and a mixture of alfalfa meal with wheat flour (equal parts by weight). When they had reached the stage of advanced scurvy they were killed. Due to a loss of appetite prior to death, the tract was usually empty except the caecum and sometimes the colon.

As shown in Chart IV—the first day there was no difference in the duration factor for the normal and scurvy duodenum but the normal ileum lived 18 minutes longer than the scorbutic. In the colon there was a difference of 50 minutes in favor of the normal strips. On the second day the normal duodenum outlived the scurvy duodenum by 185 minutes, the normal ileum exceeded by 134 minutes while the normal colon lived 81 minutes longer than the scurvy colon. The story for the third day is practically the same, since the normal duodenum lived 169 minutes, the normal ileum 167 minutes and the normal colon 165 minutes longer than the scorbutic strip. The fourth day the normal duodenum showed an average life of 65 minutes while none

of the scurvy segments showed activity. The normal ileum outlived the scurvy ileum by 16 minutes while the normal colon exceeded the scurvy colon by 105 minutes.

The scorbutic colons usually showed activity or survival for 96 hours, and in every experiment the length of time which the normal strips survived and contracted exceeded that of the scorbutic, not only on the first day but on the second, third, and fourth days after death.

Chart V—In determining the rate of rhythmic contractions for the first day, 1st and 4th hours, the normal duodenum contracted more rapidly than the scorbutic. The scurvy ileum showed a hypermotility. At the beginning of the first hour, the rate of the scurvy colon surpassed the normal but at the end of the fourth hour the record was reversed. On the second, third and fourth day the curves showed that the normal strips uniformly surpassed the scorbutic segments.

In computing the work based on the amplitude and number of rhythmic contractions for the first and fourth hours, the record showed that more work had been done by the normal segments than by the scurvy segments with the exception of the scurvy ileum for the first day, first hour. The records for the three succeeding days demonstrates the greater efficiency of the normal strips.

Chart VI and VII—A count of the number of tonus waves was made for the 1st and 4th hours; also the amplitude of these waves was measured in both the scorbutic and normal tracings for the four successive days. Tonus of the intestinal wall of the moribund scorbutic guinea pig showed a slight increase in the duodenum with a marked increase in the colon. However, there was a decrease in the tone of the scorbutic ileum.

In estimating the number of duodenum, ileum and colon segments which were capable of spontaneous activity and tone during the four successive days, the percentage was much higher for the normal than for the scorbutic strips.

In the scurvy guinea pig, we found in general that the colon showed initial hypermotility. The colon of the animal with most advanced scurvy gave the highest amplitude of rhythmic contractions, three of them reaching 97, 95 and 90 millimeters while the highest amplitude recorded for the normal colon was 87. Extreme amplitudes were also noted

in a guinea pig showing practically the same degree of scurvy.

If the autonomic activity of the intestinal strip as recorded by the method herein employed is a true index of the physiological condition of the local intestinal motor and muscular mechanism, we may conclude that deficiency of Vitamin (B) on the whole diminishes the motility both in amplitude and rate of contractions and shortens the time during which excised strips exhibit spontaneous contractions. Deficiency of Vitamin C likewise shortened the duration of the excised strip and diminished the rate of rhythmic contraction with the exception of the ileum the first hour of the first day, but tonus and amplitude of rhythmic contraction were increased.

According to the results of this experiment, deficiency of Vitamin (B) affects the mechanics of digestion since stasis and hypomotility seem to characterize the beriberi intestinal tract. Lack of Vitamin (C) decreased the duration of the strips also diminished the rate of rhythmic contractions; but the increased amplitude of the rhythmic contractions indicated hypermotility in the colon and also some hyperactivity in the duodenal strip. The tonus of the intestinal wall was considerably increased in the scorbutic strip.

In comparing the effect of deficiency of Vitamin (B) with the effect of deficiency of Vitamin (C) on the activity of the digestive tract, it would appear that the effects are opposite. Lack of (B) causes a decrease of activity with retention of the intestinal contents while lack of (C) does not interfere with peristaltic digestion to as great a degree. However, the results seem to indicate a speeding up of motility in the acute moribund stage.

In as much as the beriberi strips of the rat and the scorbutic strips of the guinea pig were unable to show motility as long under the same experimental conditions as the normal, the experiment indicates that the mechanics of digestion are involved in both the deficiency of Vitamin (B) and (C). However, the effects on motility in (B) deficiency may be quite different pathologically from the effects of (C).

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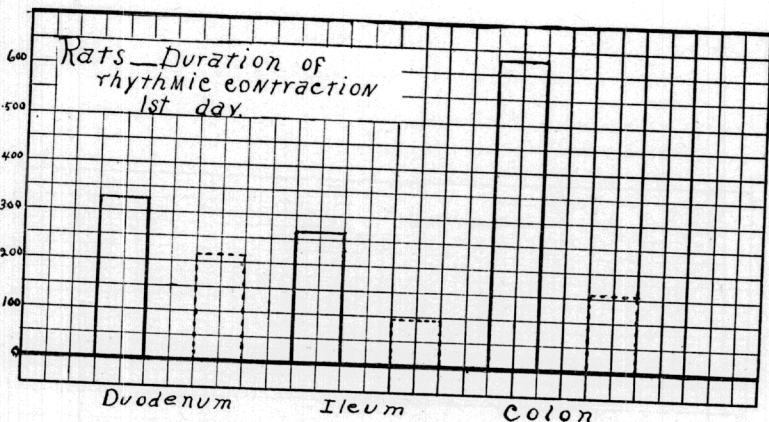


Chart I.—The length of time which excised strips can exhibit spontaneous contractions and tone in oxygenated Locke's solution is longer in the normal duodenum, ileum, and colon than in the polyneuritic segment. Normal—; Polyneuritic.....

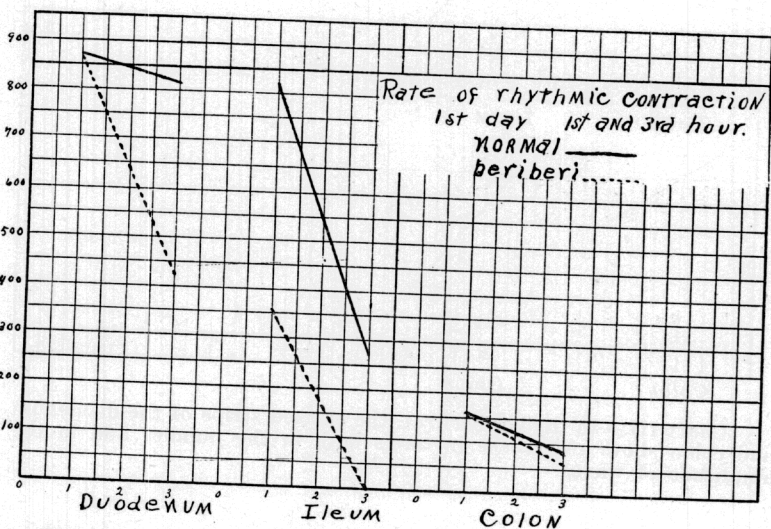


Chart II.—The rate of rhythmic contraction decreases rapidly in the duodenum and ileum segments of the polyneuritic rat. The rate of spontaneous contraction is lower in the polyneuritic colon and the decline gradual.

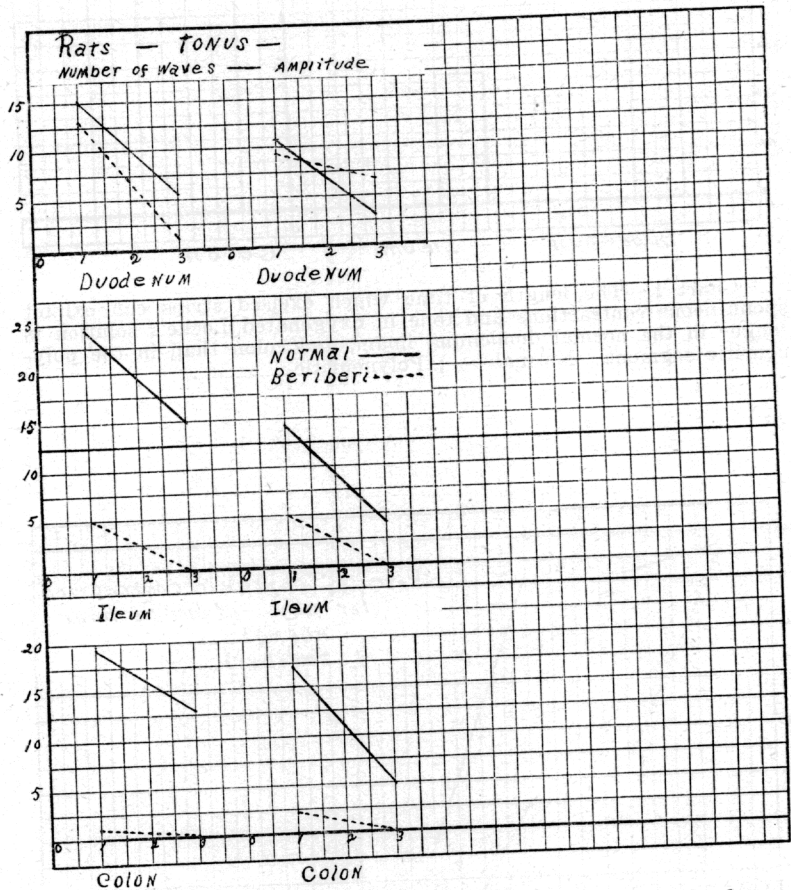


Chart III.—In the beriberi rat, the excised strips of the duodenum and colon show a decrease in tonus both in the number and in the amplitude of waves.

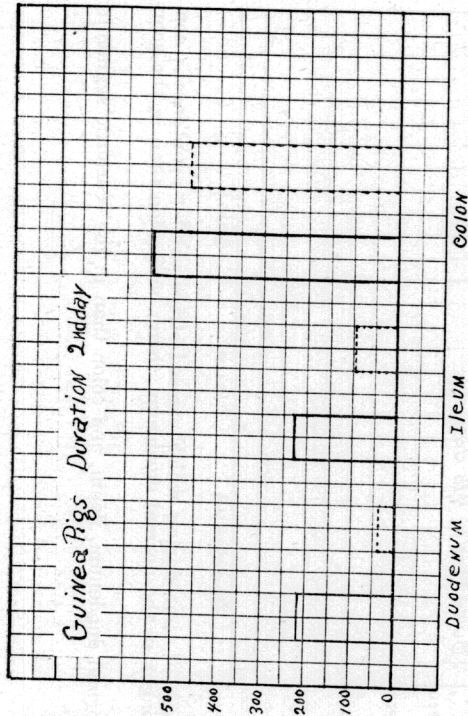
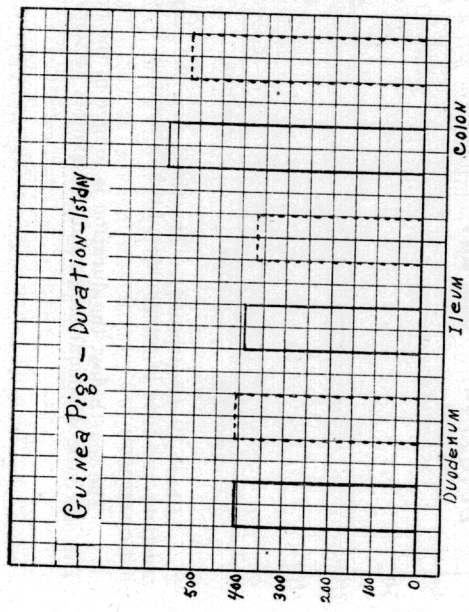


Chart IV.—The first day, the length of time during which excised strips can exhibit spontaneous contractions and tone in oxygenated Locke's solution is longer in the normal ileum and colon than in the scorbutic strip. There is practically no difference in the duration of the normal and scorbutic duodenal segments.

The second day, the duration is longer in the normal duodenum, ileum, and colon than in the scorbutic strip.

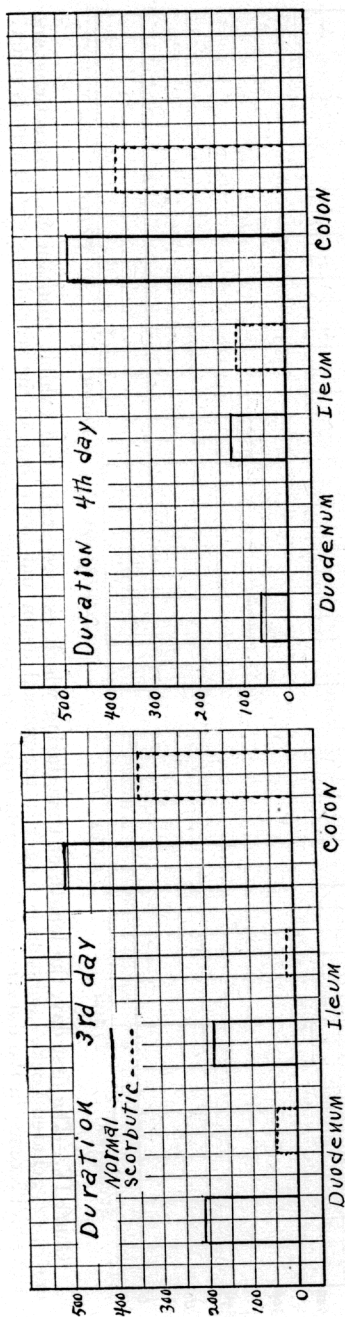


Chart IV (Continued).—The third day, the length of time during which excised strips exhibit spontaneous contractions and tone in oxygenated Locke's solution is longer in the normal duodenum, ileum, and colon than in the scorbutic segment.

The fourth day, the duration is longer in the normal duodenum, ileum, and colon than in the scorbutic segments. The scorbutic duodenal strips did not exhibit activity.

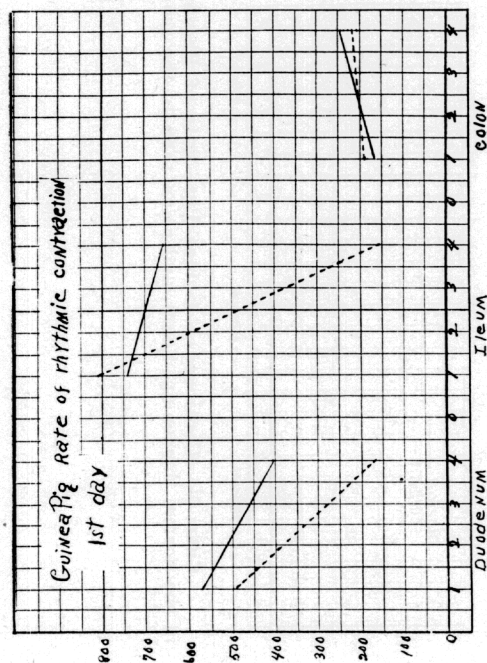
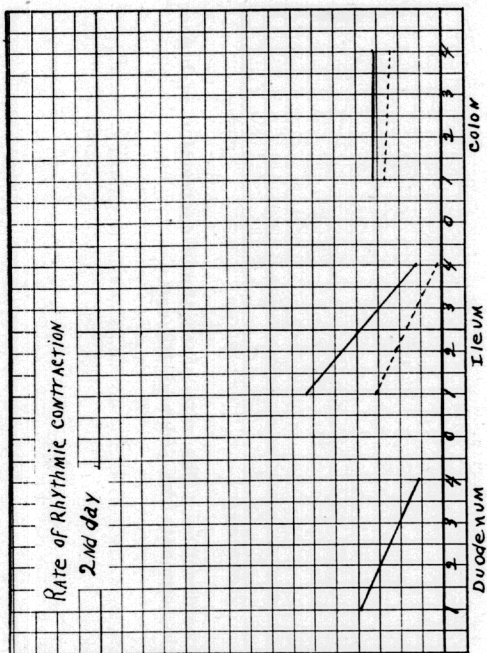


Chart V.—The rate of rhythmic contraction in the scorbutic duodenum the first day is lower than the normal. The scorbutic ileum exhibits hyperactivity with a marked decrease in rate. The scorbutic colon exceeds the normal in rate for the first hour. Normal——, scurvy-----

The second day the rate of rhythmic contraction is higher in all of the normal segments than in the scorbutic strips.

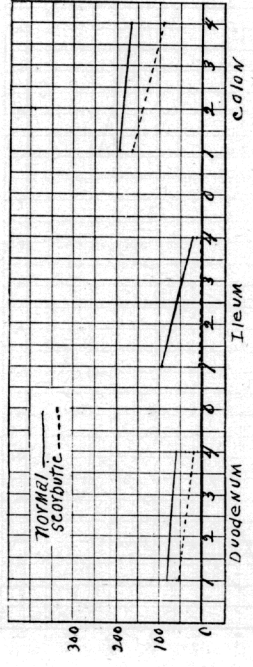
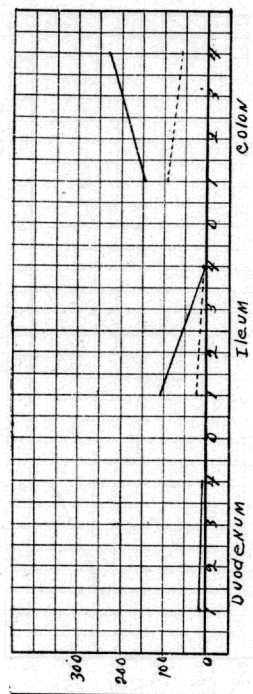


Chart V. (Continued).—Guinea Pig—Rate of Rhythmic contraction. The rate of rhythmic contraction is higher in the normal duodenum, ileum, and colon than in the scorbutic segments the 3rd and 4th day.

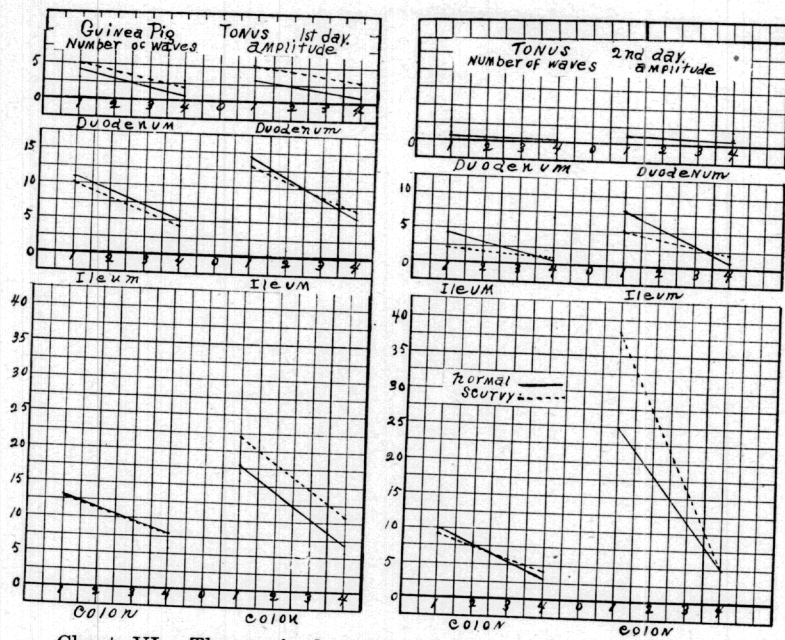


Chart VI.—The excised strips of the scorbutic duodenum and colon the first day show an increase in both number and amplitude of tonus waves for the first and fourth hours. The reverse is true in the scorbutic ileum.

The second day, the scorbutic colon showed marked hypermotility.

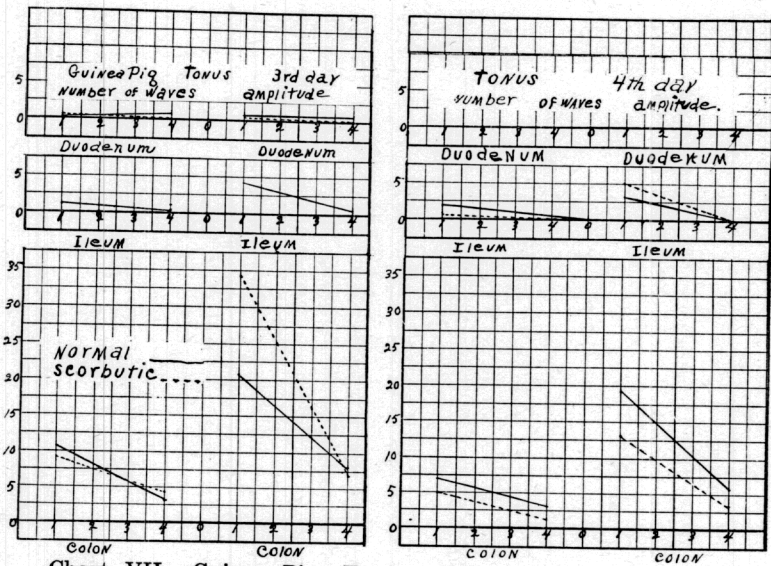


Chart VII.—Guinea Pig—Tonus. The third day record shows marked hypermotility in the scorbutic colon. There was no duodenal activity the fourth day. The normal colon strips showed more tone than the scorbutic.