

amount of instillate of either test meal emptied from the stomach whether or not retrograde pacing of the Roux loop was employed. Also, when Phase III of the IDMEC occurred in the loop during the 20-min test period, gastric emptying was especially slow. Interdigestive electrical patterns were seen more often with the 5% than with the 25% instillate, probably because the hypertonicity of the latter inhibited the interdigestive cycles. With vagotomy, the interdigestive pattern may not always be interrupted after a meal.<sup>14,15</sup>

Previous studies from this institution<sup>16</sup> have shown that in dogs with an isolated, but myoelectrically continuous jejunal segment, transit of glucose and saline through the segment was longest during Phase I and shortest during phase III of the interdigestive cycle. One might have expected that in this study the increase in action potentials (contractions) during phase III would have encouraged more rapid gastric emptying. However, Weisbrodt et al.<sup>17</sup> showed that, when duodenal contractions were numerous and antral contractions infrequent, canine gastric emptying was slow. They explained this on the basis that duodenal contractions offered resistance to gastric outflow. These findings are in keeping with ours. In the present study, the rate of gastric emptying decreased as the incidence of action potentials, hence the amount of resistance offered by the Roux loop, increased.

The instillation of either 5% or 25% glucose into the gastric remnant had no effect on the frequency of pacesetter potentials in the Roux loop, nor did aspiration of the stomach at the end of 20 min. As expected, retrograde pacing increased the frequency and reversed the direction of propagation of the pacesetter potentials. However, pacing did not increase the number of action potentials, so that it must have produced its effect on gastric emptying by increasing frequency and/or reversing the direction of propagation of the pacesetter potentials. Nonetheless, Phase III, which seemed to have a maximal slowing effect on gastric emptying, was propagated in an aboral direction whether or not retrograde pacing of an intestinal loop was employed. This was also observed by Sarr, et al.<sup>18</sup> Thus, the magnitude of contractile activity in the Roux loop and the direction of contractile propagation both influence the rate of gastric emptying.

#### DISCUSSION

DR. EDWARD M. COPELAND, III (Gainesville, Florida): If you have electrodes on the Roux-Y limbs, in a paced and not-paced setting, you could potentially answer one of Dr. Vogel's questions about vagotomy and its effect on electrical activity. I would like to ask you what those electrical tracings were in your Roux-Y limbs.

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E. R. WOODWARD, M.D. (Gainesville, Florida): The authors present additional information on the electrophysiology of smooth muscle. Our knowledge on this subject has lagged far behind that of the myocardium and even that of skeletal muscle. The important contributions of this group continue to close the gap.

Solid phase emptying is usually delayed in the vagotomized patient with a Roux-en-Y reconstruction. We have used this method for the

occasional patient with the dumping syndrome which is refractory to medical treatment. We have a 5 to 10-year follow-up on 15 patients; 11 have experienced lasting relief. In the four patients with a less than satisfactory result, only one has persistent dumping; three patients have symptomatic gastric retention.

Solid phase emptying is determined using technetium 99 sulfur colloid incorporated in egg white. The egg is poached and, following ingestion serial emptying is followed with the gamma camera. One recent patient preoperative study showed half of the isotope present in the stomach at 28 minutes, whereas postoperatively the half-time was 77 minutes. In the second patient the isotope was completely absent from the stomach at 1 minute preoperatively, whereas in the postoperative examination more than half the isotope was still present at 8 hours.

Since slow emptying is even more common than rapid emptying in the Roux-en-Y patient, we ask the authors if antegrade pacing of the Roux-en-Y limb is a possibility.

DR. G. ROBERT MASON (Irvine, California): I have suggested that perhaps one of the causes of delay might be what I call intestinalization of the motility pattern of the stomach being driven by a more rapid pacemaker in the small intestine.

Now it would appear that we have a similar pattern that might well apply to the Roux-Y limb; that is to say that you have a more rapid oscillator driving the Roux-Y limb. You have an ideal opportunity here to have what Dr. Kelly called an electroenterogram.

I wonder if your controlled studies might have shown that before and after this Roux-Y limb there was an alteration in its oscillation pattern, or basic electric rhythm.

DR. KEITH A. KELLY (Closing discussion): Dr. Woodward, we have done some work with antegrade pacing of the Roux loop, but the experiments are still in a preliminary stage. It is attractive to think that by pacing the Roux loop forward we might speed gastric emptying in certain patients, but I just do not have the data to answer this question.

Our experiments were not designed to test the effect of vagotomy on the Roux loop, so that I also cannot answer the questions raised by Dr. Copeland and Dr. Mason. I can say, however, that no gross disruption of electrical pattern in the Roux loop was present in our dogs, all of whom had had vagotomy. When the Roux loops were made, we did transect the bowel, and so separated the jejunum from the duodenal pacemaker. Thus, the frequency of the pacesetter potentials dropped about 25% in the Roux loop. However, the rhythms were still regular. We did not identify, for example, ectopic pacemakers in the loop under the conditions of our experiment. But, the effect of vagotomy on the electrical patterns in a Roux loop needs more careful study.

Getting back to pacing, the attraction to me is that pacing is a temporary phenomenon. The patient could switch on the pacing unit when he wished to alter the pattern of emptying in his loop, and then he could switch it off afterwards. Most of our surgical reconstructions slow emptying permanently. But, with pacing the patient could create the slowing at will. We need some careful clinical testing now.