Freezing of the Intact Rat Stomach: An Indication of the Biologic Potential of the Technic

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PROFOUND GASTRIC HYPOTHERMIA was begun in 1961 as an effort to provide a conservative therapeutic approach for patients with peptic ulcer disease. By damaging the gastric secretory cells, it was hoped that their regeneration would be retarded, thus achieving a diminution in the secretion of an active peptic gastric juice.1

The first trials with the method of freezing isolated canine gastric pouches indicated that prolonged periods of achlorhydria could be achieved. This circumstance and the dramatic relief of ulcer pain attending clinical gastric freezing suggested that something akin to a physiological gastrectomy might be accomplished by gastric freezing. Further trials have indicated quite definitely, however, that gastric freezing of the intact canine or human stomach (unlike the isolated canine pouch) is rarely attended by prolonged depression of gastric secretory responses. In fact, the experience of most observers has been that: (1) although immediate symptomatic improvement is quite uniformly attained, the duration of such relief is variable and unpredictable; (2) whereas significant reduction in gastric acid secretion is often observed initially, most patients experience a return of acid secretion to prefreeze levels within 3–6 months; (3) current technics of clinical gastric freezing produce only a patchy freeze of incomplete distribution; and (4) isolated areas of overfreeze leading to necrosis may occur. These observations have considerably dampened earlier enthusiasm for gastric freezing.2, 3

Conflicting results have been reported from the experimental laboratory. Shulman and Ferguson4 found only transient periods of achlorhydria following a single freeze in isolated canine gastric pouches. On the other hand, Goodale et al.5 reported that following a single episode of hypothermia in which a tissue temperature of −2° to −4° C was maintained for 40 min., pouches could be rendered achlorhydric to a meat-meal stimulus for an average of 16.2 weeks.

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Since the mid-nineteenth-century days of William Beaumont and Theodor Schwann the effect of lowered temperature upon gastric digestion has been known. The aim of gastric freezing should be to expose each mucosal cell to an equal and exact degree of profound cold for a precise period of time, with no cells subjected to excessive injury. While simple in concept, such an ideal is difficult to achieve. Only under conditions in which this circumstance is approached, however, can the biologic potential of gastric freezing be assessed.

McFee et al. demonstrated that gastric freezing affords marked protection against stress ulceration in the rat. More recently, the work of Buchan et al. indicates that prolonged periods of achlorhydria can be anticipated following freezing of the intact stomach of the rat. The stomach of the rat should serve as a better experimental preparation by which to approximate ideal perfusion than is available in the current technics of freezing the intact stomach of either dog or man.

METHODS

Freezing

The technic of freezing the stomach of the rat has been described elsewhere. The apparatus employed is illustrated in Fig. 1. Ninety-five per cent alcohol was pumped by a standard Swenko gastric hypothermia unit through a series of copper coils immersed in a dry ice-alcohol bath maintained at $-75^\circ$ C. From this bath, the coolant was passed to a "Y" connector where most of it was diverted back into the machine. About 75 ml./min., however, were trans-

![Fig. 1. Schema showing operation of gastric hypothermia unit employed in freezing intact stomach of rat.](image-url)