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Relationship of Ulcer Pain to pH and Motility of Stomach and Duodenum. (21148)

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The exact cause of the pain of peptic ulcer has been the subject of controversy for many years. Following Carlson's(1) description of contractions of the stomach synchronous with ulcer pain, this pain was related to motility until Palmer(2-4) found that, in patients with active peptic ulcer, the instillation of 0.5% hydrochloric acid by gastric tube reproduced the pain, and immediate relief followed aspiration. Palmer concluded that ulcer pain resulted from direct chemical irritation of pain fibers in the base of the ulcer crater. Bonney and Pickering(5) confirmed Palmer's work. Ruffin and coworkers(6) reported observations on 56 peptic ulcer patients given an acid barium mixture during fluoroscopic examination. When pain was produced, persistent spasm of either stomach or duodenum occurred. If no pain developed, normal gastric motility and emptying were seen although the acid barium mixture was actually demonstrated in the ulcer crater.

Rollins and Friedlander(7) recorded kymograph tracings of either gastric or duodenal motility in patients with duodenal ulcer while ulcer pain was produced by the intragastric injection of 0.5% HCl. The administration of hexamethonium decreased motility, but did not relieve the ulcer pain. Palmer(8) studied 26 ulcer patients known to have had a positive acid test. Administration of anticholinergic drugs failed to alter the pain response in 23. Dragstedt and coworkers(9) investigated 5 patients with duodenal ulcers and with positive acid tests. Following surgical division of the vagus nerves, intragastric administration of hydrochloric acid produced the characteristic pain response for a period of 5-6 days postoperatively.

In view of the conflicting findings reported, it was decided to make further observations on patients with peptic ulcer pain under conditions whereby simultaneous motility records and pH determinations were obtained from both stomach and duodenum.

Method. Patients selected for study had active but uncomplicated duodenal ulcers. A triple-lumen tube was passed under fluoroscopic control into the duodenum; one lumen was used for inflating a balloon which recorded duodenal motility; another was used for periodic aspiration of duodenal contents; and the third lumen was used for the administration of N/10 HCl. A double lumen tube was then introduced into the pyloric antrum under fluoroscopic control. One lumen was

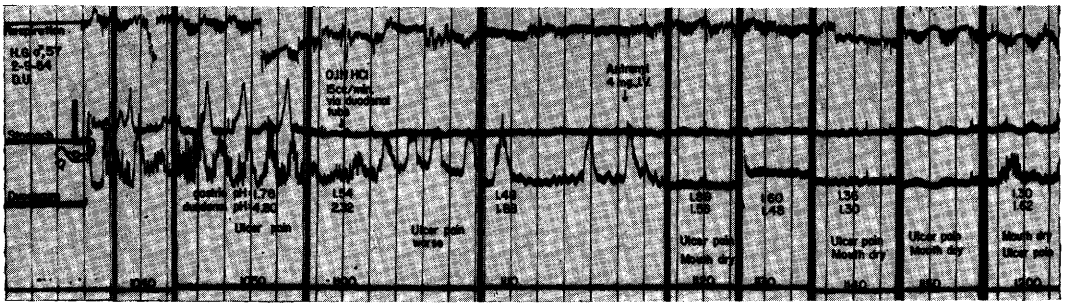

FIG. 1.

used for inflating a balloon which recorded gastric motility and the other was used for periodic aspiration of gastric contents. The gastric and duodenal motility were recorded on a multichannel recording oscillograph(10). The pH of gastric and duodenal aspirates was determined with a Beckman model G pH meter.

Results. I. 1-26-54. In a pilot study it was found necessary to introduce N/10 HCl into the duodenum at 180 drops/min. to reduce pH; ulcer pain did not occur until duodenal pH fell to 1.65.

II. On 2-9-54 gastric and duodenal motility and pH determinations were made on H.G., a 57-year-old white male (Fig. 1). Spontaneous ulcer pain was present initially; duodenal pH was 4.80, and gastric and duodenal activity were present. With the administration of N/10 HCl into the duodenum, duodenal pH dropped to 1.88 and ulcer pain was intensified. Duodenal motility continued unchanged; gastric motility ceased (as previously described by Quigley *et al.*(11) and others). Four mg of Antrenyl, Ciba (diethyl (2-hydroxyethyl) methylammonium bromide alpha-phenyl-cyclohexane-glycolate) was administered intravenously. Within 2 minutes all duodenal motor activity ceased for the duration of the study. However, duodenal pH remained between 1.30 and 1.62 and when pain persisted.

III. A.F., a 31-year-old Negro male was studied on 2-20-54. Initially the patient had only gastric motor activity, with a duodenal pH of 7.65. After the introduction of N/10 HCl, the duodenal pH dropped to 1.76 and simultaneously the patient experienced ulcer pain. Gastric activity ceased and duodenal motility began. Ten mg of Pathilon, Lederle (3 - diethylamino - 1 - cyclohexyl - 1 - phenyl-1-propanol ethiodide) was given intravenously. All motor activity of the duodenum ceased. The patient experienced slight momentary relief following which the pain markedly increased in intensity. The duodenal pH fluctuated between 1.31 and 1.40. When the HCl drip was stopped and normal saline was introduced into the duodenum, the duodenal pH gradually rose to 3.01 and the ulcer pain disappeared.

IV. H.T., a 47-year-old white male was studied on 2-27-54. Initially the patient had gastric and duodenal motor activity with a duodenal pH of 6.28. After the introduction of N/10 HCl for 10 minutes, the duodenal pH dropped to 1.55 and ulcer pain immediately began. Duodenal motility continued unchanged and gastric motor activity was reduced. The patient was given 30 mg of Probanthine, Searle (Beta-diisopropylaminoethyl xanthene-9-carboxylate methobromide) intravenously. Duodenal motor activity ceased for the duration of the study. However, ulcer pain persisted unabated. Because of the severity of the pain the HCl drip was stopped; at this point the duodenal pH was 1.40. Then 30 cc of an antacid was introduced into the duodenum and 7 minutes later duodenal aspiration started. Two minutes later duodenal pH was 4.02 and the patient was partially relieved; after 10 minutes the duodenal pH reached 6.02 and the patient was free of pain.

V. E.L., a 39-year-old white male was studied on 4-20-54. The patient displayed little gastric activity throughout the study. Intensive duodenal motility was present ini-

tially and continued after N/10 HCl drip was started. The patient experienced evanescent periods of mild distress; there was no consistent correlation between pain periods and duodenal contractions. Duodenal pH remained close to neutrality. Following the intravenous administration of 1.2 mg of atropine, duodenal contractions were markedly reduced in both frequency and amplitude. Six minutes after injection of atropine the duodenal pH declined to 1.68 and the patient noted moderately severe pain.

VI. In 3 additional patients with duodenal ulcer, the intraduodenal infusion of N/10 HCl inhibited gastric motility but failed to produce pain although the duodenal pH dropped to low levels.

Discussion. In most subjects, spontaneous gastric and duodenal motor activity were initially present. The intraduodenal administration of N/10 HCl invariably abolished gastric motility. It was found that surprisingly large volumes of N/10 HCl given at a rate of more than 180 drops/min. were required to drastically reduce the duodenal pH. For example, in one study 1300 cc of N/10 HCl was infused into the duodenum in a 60-minute period to reduce the duodenal pH to 1.68.

When the duodenal pH dropped below 1.88, pain of a persistent, burning nature occurred in 4 of 7 patients. The pain was always described as being characteristic of the patient's spontaneous ulcer pain. No change in the frequency or amplitude of duodenal contractions occurred with the onset of ulcer pain. This ulcer pain was not abolished by the anticholinergic drugs used, although duodenal motor activity was terminated. When the duodenal pH was elevated by neutralization or duodenal aspiration, pain was relieved in all cases.

Summary and conclusions. 1. In these experiments, ulcer pain was produced in 4 of 7 duodenal ulcer patients by the intraduodenal administration of N/10 HCl at a rate which lowered duodenal pH to 1.88 or less. 2. Onset of ulcer pain was not associated with any change in duodenal motility. 3. Ulcer pain induced by intraduodenal HCl was not relieved by anticholinergic drugs, even though duodenal motility was abolished. 4. When duodenal pH was elevated by neutralization or aspiration, ulcer pain was relieved. 5. Intraduodenal HCl constantly inhibited motility of the gastric antrum.

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