HEIDELBERG pH CAPSULE GASTRIC ANALYSIS

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Introduction

Proper digestion is a prerequisite for optimum health, and incomplete or disordered digestion can be a major contributor in the development of many diseases. The problem is not only that ingestion of the best nutritional substances may be of little benefit when breakdown and assimilation are inadequate, but also that incompletely digested macromolecules can be inappropriately absorbed into the systemic circulation. This can lead to various immune complex deposition diseases, and this process is now theorized to be an integral part in the etiology of food allergies.

The maintenance of proper bowel flora is also dependent on appropriate digestion. A healthy flora is known to be important for proper immune function, vitamin absorption, and the prevention of opportunistic infections, such as Candida albicans, in the gut (see Chapter IV:Bowel Toxemia).

The Heidelberg gastric analysis technique was developed to measure the pH of the digestive tract and determine the acid secretory ability of the parietal cells. Its use of radiotelemetry allows the gathering of this important information in a convenient and accurate manner.

The Heidelberg pH capsule system had its origin over 20 years ago at Heidelberg University in West Germany. In research sponsored by Telefunken, a West German electronics firm, the inventor, H.G. Noeller, studied gastric acidity in 10,000 people. Since then, over 100 studies have utilized the Heidelberg system to investigate various aspects of digestion.[1-7]

In the United States there are over 300 physicians utilizing this technique and equipment as a screening device for measuring the pH of the digestive system.

Clinical Application

Gastric acid secretion is a fundamental step in digestion and assimilation, particularly of proteins and minerals. Although much is said about hyperacidity conditions, probably more significant health problems are caused by hypochlorhydria and achlorhydria. Direct measurement of gastric acid secretion through intubation and aspiration is uncomfortable and unacceptable to many patients. The Heidelberg pH capsule system offers a convenient and accurate outpatient testing system to clinicians interested in evaluating gastric function.[8]

Hydrochloric acid, pepsin and intrinsic factor are involved directly in digestion and contribute to the chemical changes in the intestines that assist in the absorption of many nutritional factors. For example, vitamin B_{12} absorption requires intrinsic factor, while calcium and iron are poorly assimilated when gastric acidity is low.[9,10]

Table 1. Common Symptoms of Low Gastric Acidity[11]
Bloating, belching, burning, and flatulence immediately after meals
A sense of 'fullness' after eating
Indigestion, diarrhea or constipation
Multiple food allergies
Nausea after taking supplements
Itching around the rectum

Table 2. Common Signs of Low Gastric Acidity[11]
Weak, peeling and cracked fingernails
Dilated capillaries in the cheeks and nose (in non-alcoholics)
Post-adolescent acne
Iron deficiency
Chronic intestinal parasites or abnormal flora
Undigested food in stool
Chronic candidal infections
Upper digestive tract gassiness

Indications

There are many symptoms and signs that suggest impaired acid secretory ability, and a number of specific diseases have been found to be associated with a- and hypochlorhydria (particularly HLA B_8 related autoimmune diseases). These are listed in Tables 1, 2 and 3.

Table 3. Diseases Associated with Low Gastric Acidity[13-23]
Addison's disease
Asthma
Celiac disease
Dermatitis herpetiformis
Diabetes mellitus
Eczema
Gallbladder disease
Graves disease
Chronic auto-immune disorders
Hepatitis
Chronic hives
Lupus erythematosis
Myasthenia gravis
Osteoporosis
Pernicious anemia
Psoriasis
Rheumatoid arthritis
Rosacea
Sjogren's syndrome
Thyrotoxicosis
Hyper- and hypothyroidism
Vitiligo

Aging

Numerous studies have shown that acid secretory ability decreases with age. Low stomach acidity has been found in over half of those over age 60.[24,25] One study of the elderly found that their tissue nutrient levels could be saturated only through the use of intramuscular supplementation; oral supplementation was ineffective. The authors speculated this was due to atrophy of various digestive organs.[26]

Physiology of Digestion in the Stomach

The epithelium of the stomach contains many gastric glands. These tubular glands consist of parietal, chief, and mucous cells. The antral portion of the stomach produces the digestive hormone gastrin whose release is stimulated by: (1) vagal nerve stimulation, (2) the physical bulk of the ingested food distending the stomach, and (3) partially digested proteins. After gastrin is absorbed into the blood stream, it is carried to the gastric glands where it stimulates the parietal cells to produce hydrochloric acid and, to a lesser extent, the chief cells to produce digestive enzymes (such as pepsin and intrinsic factor). With adequate stimulation, the parietal cells increase their production of HCL by as much as eightfold.

When the pH of the stomach reaches about 2.0 the gastrin mechanism becomes blocked, and feedback causes the parietal cells to decrease production of HCL. This concentration of hydrogen ions (by a factor of 100,000) is a very energy-dependent process.

Dietary protein (derived almost entirely from meats and vegetables) is composed of amino acids held together by peptide linkages. Pepsin I (gastricin) and pepsin II cleave these in the stomach and are most active at pH's of between 2.0 and 3.0. They are completely inactive at a pH of about 5.0. Consequently, in order to have any significant digestive effect in the stomach, the gastric juices must be acidic.

Pepsin and gastricin are capable of initiating the digestion of virtually all forms of protein (including collagen fibers), but are only able to process protein into proteoses, peptones, and large polypeptides.

Trypsin (a protein-splitting enzyme secreted by the pancreas) completes the process, yielding amino acids and dipeptides. The biochemical messenger which stimulates this pancreatic secretion is the acidic bolus of food moving from the stomach into the duodenum.

Procedure

Equipment:

The Heidelberg System consists of the following equipment:

1. Radiotelemetry capsule - a hard plastic capsule (about 2 cm long by 0.8 cm in diameter) which contains a miniature radio transmitter, a pH sensing device and a saline activated battery.
2. Waistband antenna - receives the signal from the capsule and relays it to the receiver.
3. Receiver/recorder - receives and translates the signal. The pH reading is displayed on a meter and recorded by a continuous printer for a permanent record. The receiver also contains a calibration probe used to calibrate each capsule with known pH 1.0 and 7.0 solutions.
4. Heater block - maintains the calibrating solutions at 37 ^{o}C.

Methods:

There are two ways in which to conduct the test: the tethered capsule repeat challenge and the flow-through method. Each gives different information and has its advantages and disadvantages. For both procedures, the test begins after the patient has fasted (food and liquid) for 8 hours.

The Tethered Capsule Repeat Challenge: In this procedure, the capsule is tethered so that it remains in the stomach while the stomach is challenged by the ingestion of a saturated sodium bicarbonate solution ($NaHC0_3$ - baking soda).[27] The challenge solution triggers a rise in stomach pH and a subsequent attempt by the parietal cells to reestablish appropriate acidity. The majority of people have a normal initial pH of between 1.0 to 2.3. Abnormalities of stomach secretions are usually found only after the stomach is challenged. (A more involved protocol can be found in reference 27.)

1. The waistband antenna is fastened around the patient's waist and the receiver/recorder is turned on and calibrated.
2. The patient swallows the capsule, which is attached to a one meter long, thin cotton thread (a small amount of distilled water is allowed). The pH reading typically starts at 7.0 and falls towards 1.0. After about five minutes, the capsule reaches the bottom of the stomach (which normally displays a pH of between 1 and 2) and the remaining thread is taped to the cheek in order to prevent movement of the capsule out of the stomach and into the intestine.
3. If the fasting pH is normal, the patient swallows the first challenge of 5 cc's of the alkaline solution. Within 30 seconds, the pH will normally rise to 7.0 and the patient is asked to lie down on his/her left side (to keep the stomach contents in as long as possible).
4. If stomach function is normal and acid is secreted sufficiently in response to the alkali challenge, the pH returns to normal (between 1.0 and 2.0) within 20 minutes.
5. The challenge is repeated up to four times, as long as the response time is within 20 minutes.

Flow-Through Capsule: In this procedure, the capsule is not tethered to a thread and is allowed to freely move from the stomach into the duodenum and the rest of the small intestine. The proponents of this method claim that this allows measurement of the gastric emptying time and intestinal pH, both of which are important parameters.

Interpretation

Results may be classified as: normal, hypochlorhydria, achlorhydria, and hyperchlorhydria.

Normal (Figure 1) - the patient successfully reacidifies after four challenges. No. 1 shows capsule entering digestive tract. No. 2 shows capsule reaching bottom of stomach and alkaline challenge occurring. No. 3 shows pH rise after swallow and subsequent reacidification within 20 minutes.

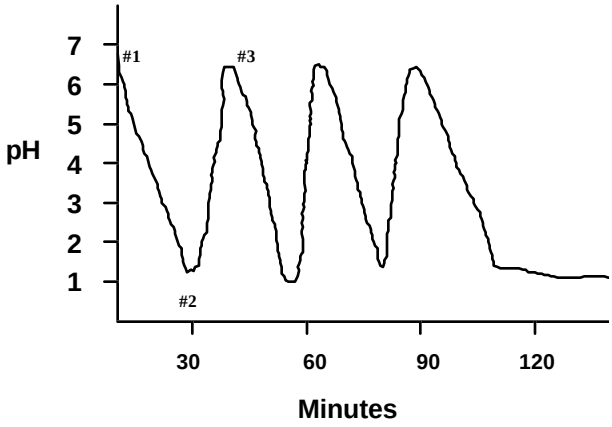

Figure 1. Normal Heidelberg Gastrogram

Hypochlorhydria (Figure 2) - the patient requires more than 20 minutes to reacidify. No. 4 shows pH of 1.0 being reached after 30 minutes. Note that on the third challenge, the pH comes back only to about 5.0.

Achlorhydria (Figure 3) - the patient's stomach shows little acid secretion and is not able to secrete enough acid to bring the pH below 4.0, even on the first challenge. No. 5 shows the pH remaining at about 4.2 for almost 2 hours.

Hyperchlorhydria - the gastrogram would show extremely rapid reacidification (within 5 minutes) after each challenge.

Depending on specific curve components, some investigators believe that mucous quantity, fresh or chronic ulcers, and acute gastritis conditions can at times be identified.

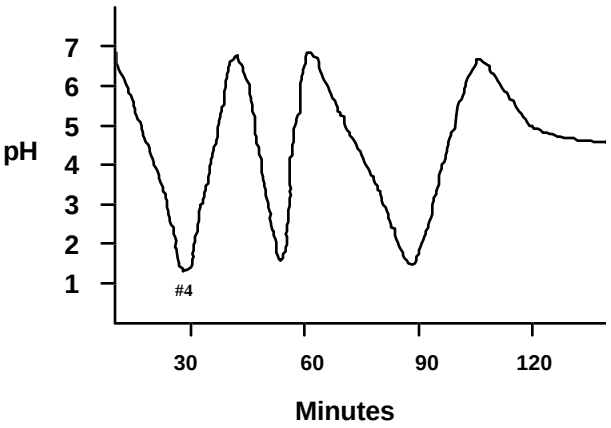

Figure 2. Hypochlorhydric Gastrogram

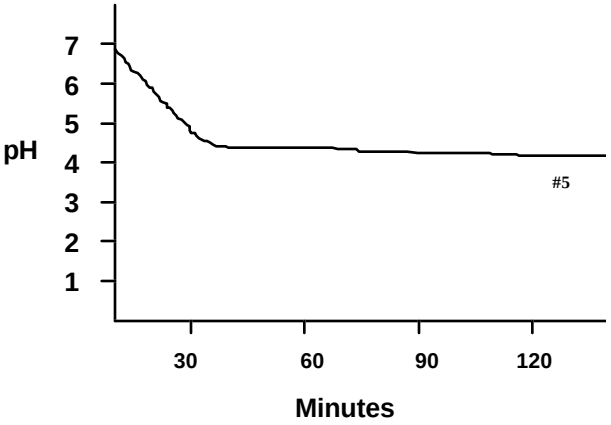

Figure 3. Achlorhydric Gastrogram

Conclusion

The Heidelberg pH Capsule system is an effective and convenient method to determine gastric acid secretory ability under conditions simulating ingestion of food. Results are extremely valuable in identifying the large number of people who have impaired secretion function. Ramifications of impaired acid secretion are widespread.

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