Telemetering of Intraenteric Pressure in Man by an Externally Energized Wireless Capsule

Abstract. Gastrointestinal intraluminal pressures have been recorded in eight patients by a pressure-sensitive telemetering capsule energized by an external, wireless source. The capsule is smaller and simpler than a battery-powered capsule, and has a relatively unlimited life. The pressure records are similar to those obtained by other sensing devices.

Pressure-sensitive radiotelemetering capsules have been designed to record intraluminal gastrointestinal pressures (*1*). Studies have demonstrated that such a capsule, within the esophagus, stomach, small intestine, or colon, will detect physiologic pressure variations and permit permanent recording (*2*). The initial telemetering studies suggested possible improvements in the original capsule design. The diameter of 1 cm and the operating life of 8 to 30 hours were not ideal. Efforts centered on a capsule to be energized by an external wireless source.

The capsule and system described here were designed and built by the Radio Corporation of America (*3*). The capsule consists of a rigid, plastic cylinder, 0.7 cm in diameter and 2.5 cm in length, enclosing a coil, capacitor, and transducer of a ferrite armature attached to a diaphragm. After the capsule is ingested, an external coil is placed around the patient. A high-frequency signal is delivered intermittently to the capsule through this external coil. Intraluminal pressure on the capsule diaphragm modulates the frequency at which the capsule circuit "rings" in response to this signal. The modulated signal is detected by the external coil and rectified, and a pressure curve is recorded (Fig. 1).

This telemetering capsule has been employed to detect and record the intraluminal pressures of the gastrointestinal tract in eight subjects. Records were obtained from the stomach, small intestine, and colon. The patterns observed are similar to those recorded by a battery-powered radiotelemetering capsule (*2*), but the base line is more stable. An example of a record from the small intestine is shown in Fig. 2*A*. The regular wave forms, noted to occur at a rate of 11 to 12 per minute, correspond to the most characteristic type of motor patterns recorded from the small intestine. The colonic pressure record (Fig. 2*B*) shows the simple, intermittent pressure waves we have noted previously in normal patients.

This pressure-telemetering system possesses definite advantages over the initial, battery-powered, radiotelemetering capsule. It is smaller and less dense,

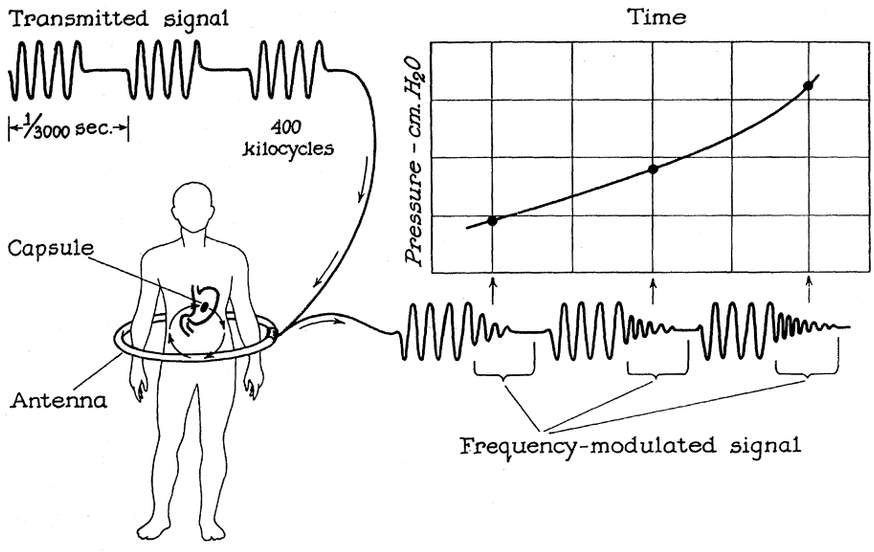

Fig. 1. Diagram of operation of the telemetering capsule.

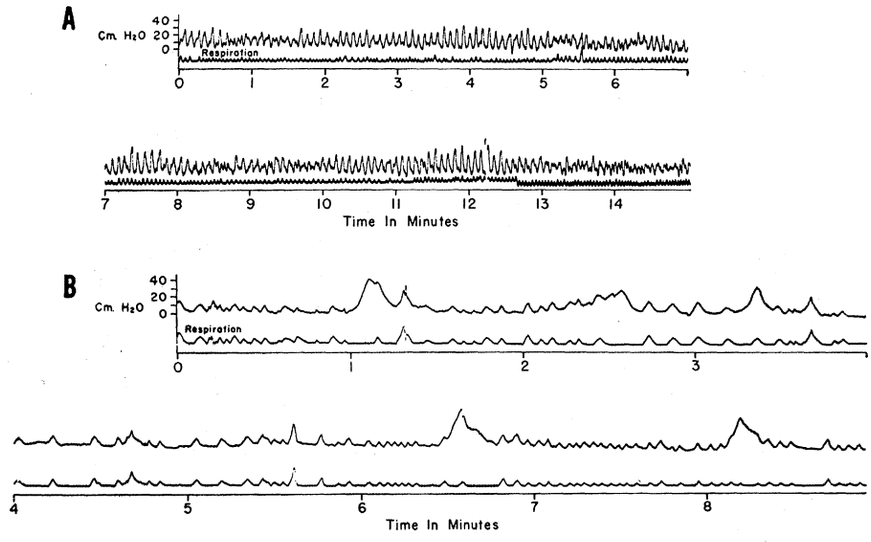

Fig. 2. Intraluminal pressure in the small intestine (*A*) and right colon (*B*).

and presumably moves more freely in the gastrointestinal tract. Since its energy is supplied from an external source, the capsule has a relatively unlimited life. Finally, the capsule is only very slightly affected by moderate changes in temperature. However, the present system is not yet ideal. The angle of coupling between the capsule and antenna is quite critical. To obtain satisfactory intraluminal pressure records in several subjects required that the subjects assume positions in relation to the antenna which were uncomfortable and probably not conducive to the recording of normal, undisturbed intestinal motility. Omnidirectional antenna systems are being developed.

The simplicity of the capsule and its effective life suggest that this system has significant potential value not only in the study of the gastrointestinal tract but in the detection and transmission of other physiologic information from different organ systems in man and animals.

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