An Electromyographic Study of the Normal Function of the External Anal Sphincter and Pelvic Diaphragm

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Electromyography has been used in recent years to study the activity of striated muscle in several specialized areas of the body. The external anal sphincter of the dog has been examined previously by Beck in 1930, and Floyd and Walls in 1953 examined this muscle in man.

Beck inserted steel needle electrodes to a depth of 4 cm. into the mucocutaneous junction. Floyd and Walls applied surface electrodes to the perianal skin. Beck found that action potentials appeared during both contraction and relaxation of the sphincter but that, once the muscle had completed its change of state, the electrical activity gradually lessened and sometimes disappeared. Floyd and Walls, however, believe that action potentials are always present, even in conditions of complete relaxation such as sleep, and that during activity the sphincter is under a considerable degree of voluntary control. They suggested, on the basis of coincident anatomic studies, that the external sphincter is composed of two types of muscle fiber; one possessing characteristics commonly ascribed to red (dark) fibers and the other with characteristics of white (pale) fibers.

Because the activity of the pelvic diaphragm has not been investigated previously and because more detailed information can be obtained by insertion of needle electrodes directly into a muscle, a study of this area was undertaken to provide a basis for electromyographic study of pathologic conditions affecting the anorectal region.

Anatomy

The investigations of Goligher, Leacock and Brossy in 1954 have led to a simpler conception of the arrangement of the striated muscle of the anal canal. They state that the arrangement of the anorectal striated muscle is as follows: the cylinder of striated muscle forming the external sphincter surrounds the internal sphincter, although its inferior margin extends to a somewhat lower level than the latter. Superiorly, the external sphincter blends indistinguishably with the puborectalis sling at the upper end of the anal canal.

Method

Normal male and female subjects, aged 25 to 65 years were investigated. They were placed in the left lateral position during
the examination unless changes of posture were required. The skin was painted with iodine and infiltrated with one half per cent procaine solution. Steel needle electrodes were then inserted concentrically into the right quadrant of the external sphincter, and posteriorly into the puborectalis muscle. In many experiments a further control record was obtained from the gluteal muscles while the anal sphincters were being studied. There was no evidence that electrodes in the anal sphincters were influenced by contraction of the gluteal muscles. The action potentials were amplified by conventional push-pull condenser coupled amplifiers and displayed on a loud speaker and cathode ray oscilloscopes. Photographic records were made from one of the cathode ray oscilloscopes.

Results

1. Resting Tone: In all subjects the anal sphincter and the puborectalis muscle were found to be tonically contracted but the degree of sphincter tone varied in different individuals. The resting tone of the external sphincter was associated with a fairly steady rate of motor unit firing. The alterations of intra-abdominal pressure associated with respiratory movement sometimes produced rhythmic changes in the motor unit firing.

Fig. 1. (A) Motor unit activity in resting external sphincter and (B) puborectalis muscles. A-E indicate identifiable motor units. Calibration millivolts and time marker 5 m.seconds in all records.

Fig. 2. Rhythmic motor unit activity in the puborectalis muscle during respiration.