GENERATION OF TACTILE STIMULATION IN THE RUMENORETICULUM

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Introduction

Tactile stimulation (TS) of the mucosa of the ruminoreticulum (RR) by gentle rubbing can evoke regurgitation, rumination, parotid salivation and changes in the form of the ruminal contractions (Schalk and Amadon, 1928; Ash and Kay, 1959; Reid, 1962). Electrophysiological studies (Leek, 1986) have demonstrated the presence, more commonly in the cranial regions of the RR, of receptors discharging when the mucosa is brushed. TS has become accepted to be an important sensory input into the regulation of digestive functions of the ruminant foregut.

The origin of TS in the gut is relative motion (RM) between the gut contents and the gut walls. The main components of this interplay are set out in table 1. RM is essential: without RM, TS appears impossible. It follows that the characteristics of RM (table 1) will be important determinants of TS.

TABLE 1. FACTORS INVOLVED IN GENERATING TACTILE STIMULATION IN THE GUT

A	DIGESTA SURFACE TEXTURE Proportions of gas:liquid:solid Particulate matter – spectrum (dimensions, geometry, rigidity), concentration, effective density Viscosity – total digesta, suspending liquid, boundary layer
B	RELATIVE MOTION Speed, acceleration, direction, duration
C	GUT WALL Sensing apparatus – sensitivity, resolution, adaptation rate, location Anatomical features – gut wall structure, lumenal geometry, mucosal architecture and physical properties

Relative motion arises from activities located inside and outside the RR. Internal sources include the local and distant effects of RR motility, and gravitational flows; external sources include transmitted effects of, for example, somatic movements and breathing. The most conspicuous of these are the effects of RR motility. This paper describes an attempt to measure some characteristics of the contractions of the cranial and caudal pillars that appear pertinent to the generation of RM between the pillars and the digesta in contact with them.

Materials and Methods

Inert radiopaque markers were surgically implanted submucosally at the midpoint of the free edges of the cranial and caudal pillars in 5 Romney wether sheep 2-3 years old. A low-irradiation video-fluoroscopy system (Beach and Reid, 1985) was used to observe and record on videotape the motion of the markers while the animals ate meal of chaffed lucerne (*Medicago sativa*) hay. The displacement of the pillar markers relative to a fixed marker on the body surface, and the speed and acceleration of the motion were then measured from the tapes at one second intervals with a light-pen system.

Results and Discussion

Measurements of the motion of the cranial pillar made during a 3 min session 90 min after an animal commenced eating are shown in figure 1. Co-ordinated ruminal contractions occurred 1.5-3 times min^{-1}. The marker displacement (base line to peak excursion) was commonly more than 65 mm and was similar for both pillars for both A and B sequences. During the contraction phase, which lasted 8 sec or longer, the speed of displacement of a marker increased rapidly at first and then decreased progressively as the pillar reached peak excursion. Dwelling time at the peak was 3-10 sec and was often longer for B than for A sequences. Relaxation involved a pattern of increasing and decreasing speed again. The mean

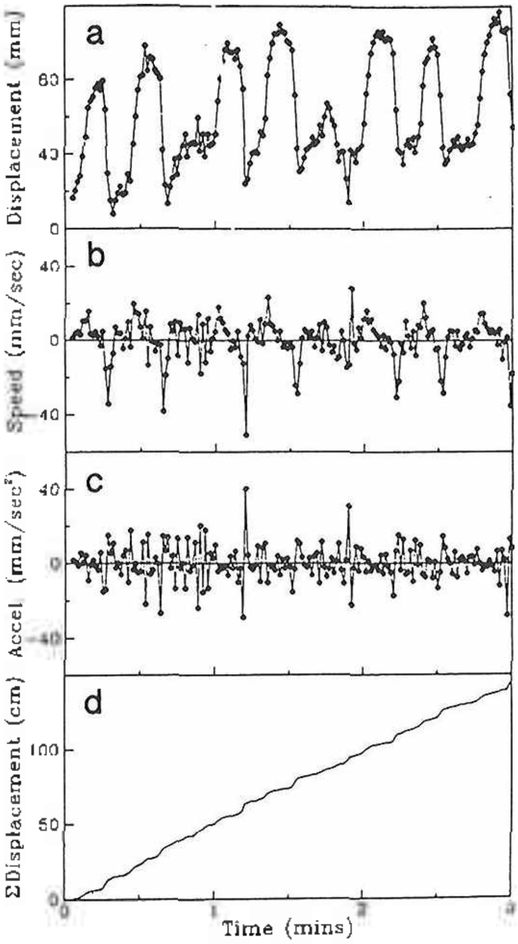

Figure 1. Motion of a marker in the cranial pillar of a sheep during a 3 min period 90 min after the start of a meal of chaffed lucerne hay.

(a) Displacement of the marker. The large excursions were caused by contractions of the pillar during ruminal contraction sequences.

(b) Speeds of displacement. Dorsal motion positive; ventral motion negative.

(c) Acceleration and deceleration.

(d) *Cumulative gross displacement (the sum of all displacement regardless of direction or cause).*

speed of displacement was of the order of 7.7 mm sec^{-1} (27.5 m h^{-1}), the maximum being 50 mm sec^{-1} (180 m h^{-1}). Speeds tended to be slower during contraction than during relaxation and to decrease as the meal continued. Rates of acceleration and deceleration were usually less than 10 mm sec^{-2} but rates greater than 40 mm sec^{-2} occurred, more commonly early in the meal.

The potential for generating TS in a given situation (digesta texture, status of sensing apparatus) will be determined by the extent of RM between digesta and mucosa. An index of the potential is the cumulative gross displacement, the sum of all motion regardless of direction or cause. The gross displacement of the cranial pillar marker was of the order of 30 m h^{-1} (figure 1 d). The extent to *which the potential is realised as RM* depends on the degree to which digesta and mucosa can move independently of each other. This will be a function of the rate of shear of the contact zone which will be determined by such properties as digesta viscosity and the compliance of the mucosa. Sharp acceleration of the pillar would be expected to increase shear rate.

(**Key Words**: Tactile Stimulation, Ruminoreticulum, Regulation)

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