Transfer of Ingesta in the Omasum of Calves

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Abstract. Three experiments were conducted to make clear the function of ingesta transfer in the omasum of calves. In Experiment 1, ingesta transfer from the reticulum to the omasum was studied. An elastic tube was inserted into the reticulo-omasal orifice through the omasum fistula. Outflow of ingesta from the reticulum through the tube was observed immediately after the second contraction of the reticulum. Furthermore, simultaneous pressure recording in the reticulum, rumen and omasal canal showed a rapid, pronounced drop in pressure of the canal at the time of the second contraction of the reticulum.

In Experiment 2, auscultation on the body surface of the omasum was carried out. Flowing liquid sounds began to be heard periodically at 4-6 weeks of age. They were recognized immediately after contraction of the omasal canal and about 12 seconds after contraction of the reticulum, although no sounds could always be heard in each reticular cycle. In Experiment 3, ingesta transfer from the omasum to the abomasum was studied. Flow of ingesta into the abomasum was recognized about 12 seconds after contraction of the reticulum by visual inspection through the abomasum fistula. From the results of Experiments 2 and 3, it can be considered that the flowing liquid sounds are attributable to the ingesta transfer from the omasum to the abomasum by the contraction of the omasal canal.

A small number of papers have been published to report the physiological mechanism affecting transfer of ingesta in the omasum. There is an opinion essential agreed upon by Wester [6], Phillipson [3], and Stevens et al. [5]. According to this opinion, it is suggested that the transfer of ingesta in the omasum may be performed in the following two stages. The first stage consists of aspirating reticular contents into the omasum and pushing out ingesta from the omasal canal into the omasal body. The second stage is pressing downward omasal contents into the abomasum. Wester [6] auscultated the omasum from the body surface in cattle and described that a high cracking sound was heard twice in a normal

reticular cycle; one occurred in consequence of transmission of contraction from the reticulum to the omasum, and the other appeared after the secondary contraction of the rumen. The relationship between the sounds and transfer of ingesta, however, was not explained in his report. In his previous study [1] on the developmental process of omasal motility in calves, the present author found that the contraction of the omasal body showed a much slower process than that of the omasal canal. It is the object of the present paper to make clear the function of ingesta transfer in the omasum of calves and to correlate this function with the results of auscultation.

Materials and Methods

Three experiments were conducted with five Holstein calves.

Experiment 1. Outflow of ingesta from the reticulum was studied

Animals and diets: Two calves, Nos. 5 and 6, 5 and 6 weeks of age, respectively, were used. Calf No. 5 had an omasum fistula, in addition to a rumen fistula. The omasum fistula, 5 cm in diameter, was set on the right side by the method of Willes and Mendel [7]. Calf No. 6 had a rumen fistula and was employed to clarify the relationship between the contraction of the reticulo-rumen and that of the omasal canal.

The calves were given hay and grain ad libitum, in addition to whole milk. Whole milk was fed at a level of 10% of body weight per day to a limit of 6 kg. They were weaned at 8 weeks of age.

Observation methods:

Calf No. 5: An elastic rubber tube 1 cm in diameter and 25 cm in length was inserted into the reticulo-omasal orifice through the omasum fistula. Its upper end was adhered closely to the orifice by its own elasticity. The position of the tube was confirmed by palpation through the rumen fistula. The exposed lower part of the tube was made to keep its position by the hand to prevent it from falling. By this method the outflow of ingesta from the reticulum was led through the tube. When ingesta were observed to flow out of the reticulum through the tube, the time was marked on a sheet of paper recording pressure changes in the reticulum. The pressure changes in the reticulum were transmitted by an air balloon connected, or by a pressure tube, to a pressure transducer and amplifiers and recorded on a sheet of oscillographic recording paper.

Calf No. 6: Pressure changes in the reticulum, rumen and omasal canal were recorded simultaneously by the kymographic method, as reported previously [1].

Experiment 2. Auscultation of the omasum was carried out on the body surface

Animals and diets: Two rumen-fistulated calves, Nos. 49 and 52, used in the previous study [1], and another rumen-fistulated calf, No. 6, used in Experiment 1, were employed. All the calves were fed the same ration as in Experiment 1.

Observation methods: All the calves were auscultated on the right side of the body surface between the 7th and 10th ribs at the level of the shoulder joint. Two calves, Nos. 49 and 52, were auscultated at regular intervals beginning at 2 or 3 weeks of age. Using calf No. 6, the time when

flowing liquid sounds were heard by auscultation was marked on the recording paper. Furthermore, with the same calf, studies were made on the relationship between the time of reticulum contraction and the time when flowing liquid sounds were heard by auscultation. Pressure changes in the reticulum were recorded on a sheet of oscillographic recording paper by the same method as described in Experiment 1. When flowing liquid sounds were heard, the time was marked on the paper.

Experiment 3. Inflow of ingesta into the abomasum was studied

Animals and diets: A calf, No. 7, 7 weeks of age was used. It had an abomasum fistula, in addition to a rumen fistula. A fistula was set in the abomasum at the arcus costarum on the right side of the body mostly by the same technique as applied to the rumen fistula. The calf was fed the same ration as used in the present series of experiments.

Observation methods: When the inflow of ingesta into the abomasum was observed by direct visual inspection through the abomasum fistula, the time was marked on a sheet of oscillographic recording paper for pressure changes in the reticulum. Pressure changes in the reticulum were recorded by the same method as applied to calf No. 5 of Experiment 1.

Results

Experiment 1

In calf No. 5, the outflow of ingesta from the reticulum was always observed immediately after the second contraction of the reticulum (Fig. 1).

The results of observation on calf No. 6 are shown in Fig. 2. Small positive pressure changes in the omasal canal were recorded at the time of the first contraction of the reticulum. At the time of the second contraction of the reticulum there was a rapid pronounced drop in pressure in the omasal canal, followed by a marked rise in pressure. In addition, another type of contraction of the omasal canal was recognized at the same time with the secondary (B-type) contraction of the rumen.

Experiment 2

In two calves, Nos. 49 and 52, flowing liquid sounds began to be heard periodi-

Fig. 1. Relationship between contraction of the reticulum and outflow of ingesta from the reticulum

Remarks.

Above: Time (1 sec) and marks of the time when the outflow of ingesta was observed.

Below: Pressure changes in the reticulum.

Fig. 2. Simultaneous recording of intraluminal pressure changes in reticulum, rumen, and omasal canal and the time when flowing liquid sounds were heard by auscultation

Remarks.

Records from above downwards: Pressure changes in the reticulum, rumen, and omasal canal, and time (1 min) and marks of the time when flowing liquid sounds were heard.

cally by auscultation of the omasum from the body surface at 4–6 weeks of age. Besides them, some short splashing sounds were heard unperiodically at 8–10 weeks of age. The splashing sounds were studied in calf No. 49 at 13 weeks of age by the pressure recording method to determine whether they were concerned with the contraction of the omasal body or not. As a result, when a balloon was inserted into the omasal body, neither splashing sounds or flowing liquid sounds could hardly be heard.

Two trials were carried out on the auscultation of the omasum from the body surface in calf No. 6. In them, flowing liquid sounds were heard immediately after the contraction of the omasal canal (Fig. 2), or

Fig. 3. Relationship between the time of reticulum contraction and the time when flowing liquid sounds were heard by auscultation

Remarks.

Above: Time (1 sec) and marks of the time when sounds were heard.

Below: Pressure changes in the reticulum.

○: Shaking of the calf.

Fig. 4. Relationship between the time of reticulum contraction and the time when inflow of ingesta into the abomasum was observed through the abomasum fistula

Remarks.

Above: Time (1 sec) and marks of the time when the inflow of ingesta was observed.

Below: Pressure changes in the reticulum.

about 12 seconds after the contraction of the reticulum (Fig. 3). No flowing liquid sounds, however, could always be heard in each reticular cycle (Fig. 2).

Experiment 3

In this experiment the time when inflow of ingesta into the abomasum was observed by the direct visual inspection through the abomasum fistula. It was started also about 12 seconds after the contraction of the reticulum (Fig. 4).

Discussion

With regard to the flow of ingesta from the reticulum into the omasum, Stevens et al. [5] described that the flow depended obviously on the opening of the reticulo-

omasal orifice, the increase of pressure inside the reticulum (reticulum contraction) and possibly the relaxation of the omasal canal (omasal aspiration), and that the flow through this orifice was seen between the reticulum contraction and the canal contraction which followed. The results of the present study in calves are in agreement with the fact just described. Therefore, it is considered that the transfer of ingesta from the reticulum may occur at the time of the second contraction of the reticulum accompanied by a rapid marked drop in pressure in the omasal canal. From the result of palpation of the flow from the omasum into the abomasum, Stevens et al. [5] mentioned that a small amount of flow often accompanied the contraction of the omasal canal when the omaso-abomasal orifice remained open, but that a greater volume of flow occurred during the contraction of the omasal body. On the other hand, from the results of their experiments with adult sheep, Ohga et al. [2] considered that a greater part of ingesta might be transferred directly from the reticulum and the anterior sacs of the rumen to the abomasum through the sulcus omasi following the second contraction of the reticulum. Moreover, Phillipson and Ash [4] reported that records of material leaving the omasum in relation to the contraction of the reticulum and rumen showed no regular pattern in sheep, and that a large flow of material might occur at a point about halfway between the diphasic contractions of the reticulum not so often as these. Accordingly, experiments with calves were conducted by the present author in order to confirm the results mentioned above.

From the results of auscultation in calf No. 6, it was clarified that flowing liquid sounds were heard immediately after contraction of the omasal canal. In two calves,

Nos. 49 and 52, these sounds were first heard at 4–6 weeks of age and could be heard until the end of the experiments, or at 29–32 weeks of age. As observed in the previous work [1], the age of 4–6 weeks corresponded to the age when the cyclic contraction of the omasal canal was first recorded in calves. It was also clear, however, that no contraction of the omasal body could be observed in these young calves, as mentioned in the previous study [1]. Consequently, it was presumed that the flowing liquid sounds might be the sounds of liquid ingesta flowing into the abomasum by the contraction of the omasal canal.

When observed by direct visual inspection through the abomasum fistula, the inflow of ingesta into the abomasum was started about 12 seconds after the second contraction of the reticulum. Flowing liquid sounds of the omasum were heard from the body surface also about 12 seconds after the second contraction of the reticulum. Moreover, in his subsequent trials, the author found that such flowing liquid sounds could also simultaneously be heard ventrally over the 7th rib on the left side, in addition to the primary auscultation area of the omasum, and that they could be heard even after the calves grew into adults. That auscultation area elucidated in the subsequent trials is situated just under the fundus of the abomasum.

From the discussion mentioned above on the results of auscultation and direct visual inspection, it can be considered that flowing liquid sounds may be originated from the flow of ingesta into the abomasum, and that the flow may be caused by the contraction of the omasal canal, as also observed by Stevens et al. [5]. In adult cattle, a certain part of ingesta may also be transferred directly from the omasal canal into the abomasum, because flowing liquid sounds

can be heard by auscultation in the same manner as in calves. Ohga et al. [2], however, reported that such a contraction of the omasal canal as could be seen in each primary and secondary contraction of the rumen in cows was not recorded in sheep. Accordingly, it is possible that a certain difference may exist between cattle and sheep in the mechanism of ingesta transfer.

No flowing liquid sounds could always be heard in every reticular cycle. Although it may be considered that this phenomenon is attributed to the irregular closure of the omaso-abomasal orifice, as Stevens et al. [5] pointed out, further studies would appear necessary.

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