Acta vet. scand. 1971, *12*, 325—334.

From the Department of Medicine II, Royal Veterinary College, Stockholm, Sweden.

# RECORDING OF THE RETICULAR MOTILITY IN CATTLE WITH EXPERIMENTAL AND SPONTANEOUS TRAUMATIC RETICULOPERITONITIS*

By

*P. Holtenius, S. O. Jacobsson* and *G. Jonson*

It has been established by ordinary clinical methods that the motility of the forestomachs does not function normally in cattle with traumatic peritonitis (*Wester* 1926, *Blood & Henderson* 1960). *Wester* and *Dougherty* (1939) using cows with rumen fistulas, demonstrated that in experimentally produced peritonitis the reticular motility was impaired. The inhibition is likely to result from the painful stimuli (*Leek* 1969).

The present investigation was undertaken to study the reticular motility in cows with experimental and spontaneous peritonitis.

## MATERIAL AND METHODS

Three cows (Nos. 1—3) of the Swedish red and white breed, free from traumatic peritonitis and aged four to five years, were used for the experimental studies. In all three, fistulas into the rumen were made by the method described by *Balch & Johnson* (1948) and *Balch & Cowie* (1955).

Traumatic peritonitis was experimentally induced one year after the creation of the fistula, in cow 1, and four months after the intervention in cows 2 and 3. The peritonitis was produced by pressing a 3-inch long nail to its full length through the wall

* The investigation was supported by grants from Statens Råd för Skogs- och Jordbruksforskning (National Council for Forest and Agricultural Research).

of the reticulum floor on its right side in a direction obliquely downwards and forwards. Scheme 1 gives further details about the course of events connected with the experiments. All three cows showed on the whole mild symptoms which disappeared

Scheme 1. The course of events connected with the produced peritonitis in the three experimental cows.

| Animal no. | Hours after the 1st perforation | Comments and manipulations |
|---|---|---|
| 1 | 0 | the nail was pressed through the wall of the reticulum |
| | 24 | the nail lying loose in the reticulum<br>the nail was pressed in again |
| | 25 | the nail was still in position<br>the nail was removed |
| 2 | 0 | the nail was pressed through the wall of the reticulum |
| | 1½ | the nail lying loose in the reticulum<br>the nail was pressed in again |
| | 24 | the nail lying loose in the reticulum<br>the nail was pressed in again |
| | 48 | the nail halfway out<br>the nail was removed |
| 3 | 0 | the nail was pressed through the wall of the reticulum |
| | 6 | the nail lying loose in the reticulum<br>the nail was pressed in again |
| | 6½ | the nail lying loose in the reticulum<br>the nail was pressed in again |
| | 24 | the nail lying loose in the reticulum<br>the nail was pressed in again |
| | 48 | ⅓ of the nail was still in position<br>the nail was removed |

gradually during two weeks. When the animals were slaughtered, adhesions were seen between the reticulum and diaphragm and between the reticulum and the lower part of the liver. In cows 2 and 3 abscesses were found in the adhesions between the reticulum and diaphragm.

The spontaneously sick animals consisted of 18 cows and two bulls of the Swedish red and white breed, aged one to 10 years, under treatment for traumatic peritonitis at the Department of

Medicine II, Royal Veterinary College, Stockholm. Only recordings from animals in which the diagnosis was subsequently confirmed by operation or after slaughtering were included in the study.

The motor activity was studied by measuring the pressure events in the reticulum via an open tipped catheter-system (*Holtenius et al.* 1971). In the experimental animals the recordings were performed before, during and after the perforating inter-

Table 1. Duration of the reticular interval before and after experimentally induced traumatic peritonitis. The values given are mean ($\bar{x}$) and standard deviation (s) of 10 intervals.

| Time of recording in hours/days before/after the 1st perforation | Interval in seconds | | | | | |
|---|---|---|---|---|---|---|
| | cow 1 | | cow 2 | | cow 3 | |
| | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ | s |
| 1 hr. before | 43 | 4 | 61 | 6 | 49 | 4 |
| 1 hr. after | 68 | 9 | 72 | 9 | 54 | 6 |
| 24 hrs. after, — before reperforation* | 47 | 2 | 112 | 15 | 62 | 11 |
| 24 hrs. after, — after reperforation* | 99 | 17 | 145 | 23 | 81 | 19 |
| 2 days after | 95 | 14 | 150 | 52 | 59 | 7 |
| 3 „ „ | — | — | 112 | 20 | 52 | 6 |
| 4 „ „ | 52 | 4 | 81 | 10 | 52 | 4 |
| 5 „ „ | 52 | 6 | 94 | 14 | 55 | 4 |
| 7 „ „ | 51 | 7 | 113 | 25 | 45 | 6 |
| 8—10 days after | 50 | 6 | 100 | 19 | 55 | 4 |
| 11—15 „ „ | 37 | 5 | 131 | 30 | 62 | 8 |

* reperforation in this case means the one performed 24 hrs. after the 1st perforation (Scheme 1).

ventions (Table 1). In the patients with spontaneous traumatic peritonitis the recordings were obtained 6 hrs. to 10 days after the first symptoms were observed.

On the recording curves 10 intervals between the reticular contractions, the durations of 10 second contraction phases of the reticulum, and the amplitude of the contractions were measured. Mean values ($\bar{x}$) and standard deviations (s) were then calculated.

The recording values of the cows with spontaneous traumatic peritonitis are compared with those of 10 normal cows (*Holtenius et al.*).

## RESULTS

### *Experimental peritonitis*

Table 1 shows that the intervals between the reticular contractions were prolonged in all three cows after the reticulum walls were perforated. The prolonged intervals were not observed until 10 min. after the nail was pushed in for the first time. In cow 1 the intervals were normal after 24 hrs. The reperforation caused a distinctly impaired reticular motility in all three cows, which persisted for two to 15 days (Table 1).

From Fig. 1 and Table 2 it can be seen that the second contraction of the reticulum was prolonged after the reticulum wall

Table 2. Duration of second contraction of the reticulum before and after experimentally induced traumatic peritonitis. The values given are mean ($\bar{x}$) and standard deviation (s) of 10 contractions.

| Time of recording in hours/days before/after the 1st perforation | 2nd reticular contraction in seconds | | | | | |
|---|---|---|---|---|---|---|
| | cow 1 | | cow 2 | | cow 3 | |
| | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ | s |
| 1 hr. before | 2.5 | 0.3 | 2.9 | 0.3 | 3.0 | 0.3 |
| 1 hr. after | 2.8 | 0.6 | 3.2 | 0.5 | 3.2 | 0.4 |
| 24 hrs. after, — before reperforation* | 3.1 | 0.3 | 3.7 | 1.0 | 3.8 | 0.6 |
| 24 hrs. after, — after reperforation* | 4.7 | 0.8 | 4.4 | 1.4 | 3.5 | 0.8 |
| 2 days after | 3.0 | 0.4 | 5.6 | 1.0 | 4.6 | 0.7 |
| 3 „ „ | — | — | 6.5 | 0.9 | 5.1 | 0.7 |
| 4 „ „ | 3.3 | 0.3 | 4.6 | 1.7 | 5.8 | 0.5 |
| 5 „ „ | 3.7 | 1.0 | 4.7 | 1.0 | 4.5 | 0.6 |
| 7 „ „ | 6.2 | 0.4 | 4.4 | 1.3 | 3.6 | 0.4 |
| 8—10 days after | 4.5 | 1.2 | 4.2 | 1.3 | 3.7 | 0.9 |
| 11—15 „ „ | 3.3 | 0.3 | 3.9 | 0.2 | 3.4 | 0.3 |

* reperforation in this case means the one performed 24 hrs. after the 1st perforation (Scheme 1).

Table 3. The amplitudes of the reticular contractions in mm Hg in three cows with experimentally induced traumatic peritonitis. The values given are mean ($\bar{x}$) and standard diviation (s) of 10 contractions.

| Time of recording in hours/days before/after the 1st perforation | Cow 1 retic. contr. | | | | Cow 2 retic. contr. | | | | Cow 3 retic. contr. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | | 2nd | | 1st | | 2nd | | 1st | | 2nd | |
| | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ | s |
| 1 hr. before | 15 | 2 | 19 | 10 | 15 | 2 | 13 | 3 | 17 | 2 | 17 | 4 |
| 1 hr. after | 16 | 2 | 14 | 5 | 13 | 1 | 11 | 2 | 10 | 2 | 11 | 1 |
| 24 hrs. after, — before reperforation* | 10 | 1 | 6 | 1 | 13 | 1 | 12 | 5 | 12 | 1 | 13 | 5 |
| 24 hrs. after, — after reperforation* | 6 | 2 | 7 | 1 | 12 | 3 | 12 | 2 | 12 | 2 | 12 | 2 |
| 2 days after | 5 | 1 | 6 | 1 | 9 | 2 | 10 | 2 | 12 | 2 | 17 | 4 |
| 3 „ „ | — | — | — | — | 11 | 3 | 12 | 2 | 10 | 2 | 12 | 2 |
| 4 „ „ | 7 | 1 | 7 | 1 | 8 | 1 | 9 | 1 | 10 | 2 | 11 | 2 |
| 5 „ „ | 5 | 1 | 8 | 2 | 6 | 1 | 8 | 2 | 10 | 1 | 12 | 2 |
| 7 „ „ | 7 | 1 | 5 | 1 | 9 | 2 | 9 | 2 | 17 | 2 | 20 | 2 |
| 8—10 days after | 10 | 2 | 9 | 1 | 7 | 1 | 10 | 2 | 14 | 1 | 18 | 2 |
| 11—15 „ „ | 13 | 1 | 11 | 3 | 10 | 2 | 12 | 2 | 12 | 1 | 22 | 3 |

* reperforation in this case means the one performed 24 hrs. after the 1st perforation.

was perforated. This was most pronounced two to seven days after the intervention (Table 2). At that time all the cows had their highest mean values between 5.8 and 6.5 sec. whereas, before the onset of the disease, the mean values were 2.5—3.0 sec.

Table 3 shows that the reticular contractions on the whole did not elevate the pressure as high, after the perforation, as before. This was most pronounced two to seven days after the reticulum wall was perforated for the first time.

*Spontaneous traumatic peritonitis*

The reticular interval in the cattle with spontaneous traumatic peritonitis was close to that of normal cows, $59 \pm 13$ and $51 \pm 7$ ($\bar{x} \pm s$) sec., respectively. Five of these animals recorded within 48 hrs.. after the onset of the disease had a mean value of 73.8 sec.

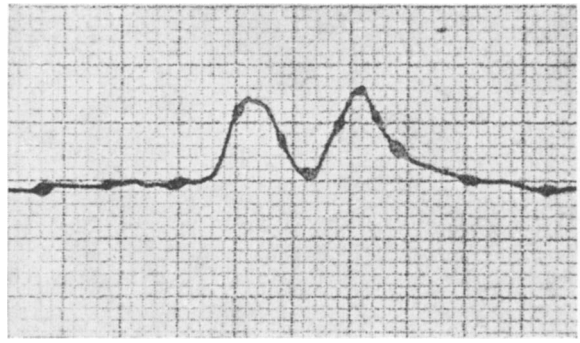

Figure 1 a. Reticular contraction from cow 3 in the experimental group before onset of disease.

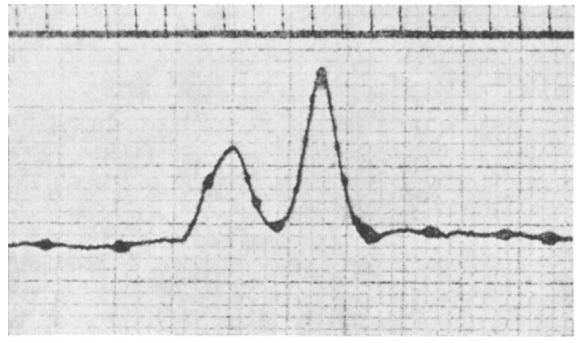

Figure 1 b. Reticular contraction from cow 3 in the experimental group nine days after onset of the disease. Notice the prolonged second contraction.

Figure 2. A recording curve of reticular contractions in a cow with spontaneous traumatic peritonitis. Notice the prolonged second contraction.

Figs. 1a and 2 show a reticular recording curve from a normal cow and a similar curve from a cow with spontaneous traumatic peritonitis. The most noticeable deviation from the normal is a prolonged second reticular contraction. This can also be seen from the mean value 5.6 ± 1.3 ($\bar{x} \pm s$) sec. for sick cows compared with 2.9 ± 0.2 for healthy animals.

The pressure elevation in the reticulum during the second contraction was lower in sick than in healthy animals. The mean value of the amplitude for the first contraction was 12 ± 4 mm Hg and for the second 11 ± 3 mm Hg. Corresponding values for healthy animals were 15 ± 4 and 23 ± 12 mm Hg.

*General observations*

Another difference noted between normal animals and cows with traumatic peritonitis of spontaneous or experimental origin was the fact that the normal cows showed much greater ability to pass the recording catheter from the atrium ruminis to the reticulum. If the catheter, during its downward passage, found its way into the atrium ruminis, it usually passed over spontaneously into the reticulum in the normal cows, whereas it often stayed in the atrium in the animals with peritonitis. For the recordings in most of the latter animals, it was necessary that the catheter was positioned in the reticulum from the beginning.

## DISCUSSION

When producing traumatic peritonitis in intact animals it is difficult to know when and where it takes place. As *Holtenius et al.* (1971) demonstrated normal reticular recordings in cows with healed rumen fistulas we considered it advisable to use such animals.

The observed changes on the recordings during the second reticular contractions occurred in both experimentally induced and spontaneous traumatic peritonitis. We have not seen it in connection with other illnesses. As a possible explanation of this delay in the fall of the pressure to the base level it could perhaps be suggested that the catheter was lying not in the reticulum but in some other position. However, we carried out repeated checks both in experimental animals and patients to see that the catheter really was in the reticulum. Another possible explanation could be that the animal tensed the abdominal muscles because of pain

and thus increased the pressure in the stomach compartments. If this explanation were correct a simultaneous recording in the ventral rumen would have revealed a corresponding increase in the pressure there but this was not the case. The altered appearance must have been caused by an alteration in the function of the reticulum. As the reticulum adheres to the diaphragm the relaxation and dilatation are very likely to take place in an abnormal manner. According to our opinion the altered appearance of the pressure curve can be explained both by the adhesions and by a reflexly altered motor activity.

Prolonged intervals between the reticular contractions were demonstrated in the experimental and the early cases of spontaneous peritonitis. This agrees with the clinical picture of an acute traumatic peritonitis described by among others *Dougherty* (1939) and *Kingrey* (1955), and mentioned by *Schmidt* as early as 1876 (ref. *Wester* 1926). Prolonged reticular intervals were also demonstrated in starved animals by *Hoflund* (1940). However, a depressed appetite cannot be the reason why the experimental animals in the present paper showed prolonged intervals as early as 10 min. after the first perforation and a distinct prolongation after the reperforation (Table 1). It is likely that the pain in connection with the perforation and peritonitis reflexly inhibits the reticular contractions in traumatic peritonitis. This agrees with *Leek's* (1969) opinion that painful stimuli reflexly inhibit reticulo-ruminal movements and that this mechanism is likely to be operative in those diseases where painful lesions are present.

Cows with peritonitis showed a reduced pressure amplitude in connection with reticular contractions. This seemed to be connected with the intensity of the clinical symptoms. It is likely that pain and diminished ingestion of food reduces the amplitudes of the contractions (*Leek*).

In all three cows, the nail worked loose fairly quickly, despite the fact that it had been inserted to its full length. Even after it had been driven in again, it worked loose in cows 2 and 3. In cow 1, it was removed after 30 min. *Wester* observed that sharp objects inserted for experimental purposes in a cow with a rumen fistula worked loose spontaneously. The probable reason why, in cows with peritonitis, the clinical symptoms subside rapidly is that the pointed object has worked loose. Not infrequently, it is found in operations on animals with traumatic peritonitis that

the object is lying loose in the reticulum but that an adhesion is present as an indication that a perforation has occurred. As the symptoms became aggravated, in our animals, after renewed perforation it would seem to be advisable to perform operation at an early stage, and preferably while the symptoms are still mild.

The impaired ability to pass the catheter from the atrium ruminis to the reticulum, often seen in connection with traumatic peritonitis, can probably also be explained as a result of impaired functioning of the latter stomach division.

## REFERENCES

*Balch, C. C. & V. W. Johnson:* A pneumatic cannula and bung for rumen fistulae in cattle. Vet. Rec. 1948, *60*, 446—447.

*Balch, C. C. & A. T. Cowie:* Notes on the establishment and closure of large rumen fistulae in cattle at the National Institute for Research in Dairying, Shinfield, Reading, England. Personal communication 1955.

*Blood, D. C. & J. A. Henderson:* Veterinary Medicine. Baillière, Tindall and Cox, London 1960, 8—27.

*Dougherty, R. W.:* Induced cases of traumatic gastritis and pericarditis in dairy cattle. J. Amer. vet. med. Ass. 1939, *94*, 357—362.

*Hoflund, S.:* Untersuchungen über Störungen in den Funktionen der Wiederkäuermagen, durch Schädigungen des N. vagus verursacht. (Investigations of functional disturbances in the forestomachs of ruminants caused by vagal nerve injuries). Svensk Vet.-T., Stockholm 1940, *45*, Suppl. 322 pp.

*Holtenius, P., S. O. Jacobsson & G. Jonson:* A method for recording the motor activity of the reticulum in cattle. Acta vet. scand. 1971, *12*, 313—324.

*Kingrey, B. W.:* Experimental bovine traumatic gastritis. J. Amer. vet. med. Ass. 1955, *127*, 477—482.

*Leek, B. F.:* Reticulo-ruminal function and dysfunction. Vet. Rec. 1969, *84*, 238—243.

*Wester, J.:* Die Physiologie und Pathologie der Vormägen beim Rinde. (The physiology and pathology of the forestomachs in cattle). Richard Schoetz, Berlin 1926, 1—110.

## SUMMARY

Using the method described in a previous publication for recording the reticulum action in normal cows the authors have investigated three cows with experimentally produced reticuloperitonitis as well as a group of cows with spontaneous peritonitis under treatment at the stationary clinic. The experimental animals were provided with permanent rumen fistulas.

In the three cows with experimentally produced peritonitis the pointed object worked loose spontaneously during the first 24 hrs.

The symptoms were mild after the first perforation and became aggravated after further perforations.

An abnormally prolonged reticulum interval was recorded immediately after the perforation and continued to be clearly distinguishable for two to three days. In the cows with spontaneous peritonitis, this change was observed only in the acute stage.

Prolongation of the second phase of the reticulum was the most pronounced finding from the recordings of the reticular movements, both in the cows with experimental peritonitis and in those in the spontaneous group. The change was at its height after two to seven days, and then subsided gradually in the experimental animals in which repeated recordings had been made.

The pressure elevation in reticulum during the contractions was lower both in the animals with experimental peritonitis and in the spontaneous group than in the healthy animals.

The cows with reticuloperitonitis also displayed impaired ability to pass the recording catheter from the atrium ruminis to the reticulum.

## SAMMANFATTNING

*Registrering av nätmagsmotoriken hos nötkreatur med experimentell och spontan traumatisk peritonit.*

Med den i ett tidigare arbete beskrivna metodiken för registrering av nätmagsmotoriken på normala kor undersöktes dels tre kor med experimentellt framkallad reticuloperitonit dels spontana fall, som var intagna för stationär behandling. Försökskorna hade försetts med permanenta våmfistlar.

På samtliga försökskor lossnade det spetsiga föremålet spontant under första dygnet. Symtomen efter första perforationen var svaga. Efter reperforation förstärktes symtomen.

Vid registrering sågs en förlängning av nätmagsintervallen omedelbart efter perforationen och den var tydligt framträdande under två-tre dygn. Även i spontanfallen var förändringen endast påvisbar i det akuta stadiet.

Det mest framträdande fyndet vid registrering av nätmagsmotoriken hos såväl försökskorna som hos spontanmaterialet var en förlängning av andra nätmagskontraktionsfasen. Förändringen var störst efter två till sju dagar och minskade därefter gradvis på försökskorna, som undersöktes vid upprepade tillfällen.

Korna med reticuloperitonit hade också nedsatt förmåga att flytta över registreringssonden från atrium till reticulum.

*(Received May 28, 1970).*