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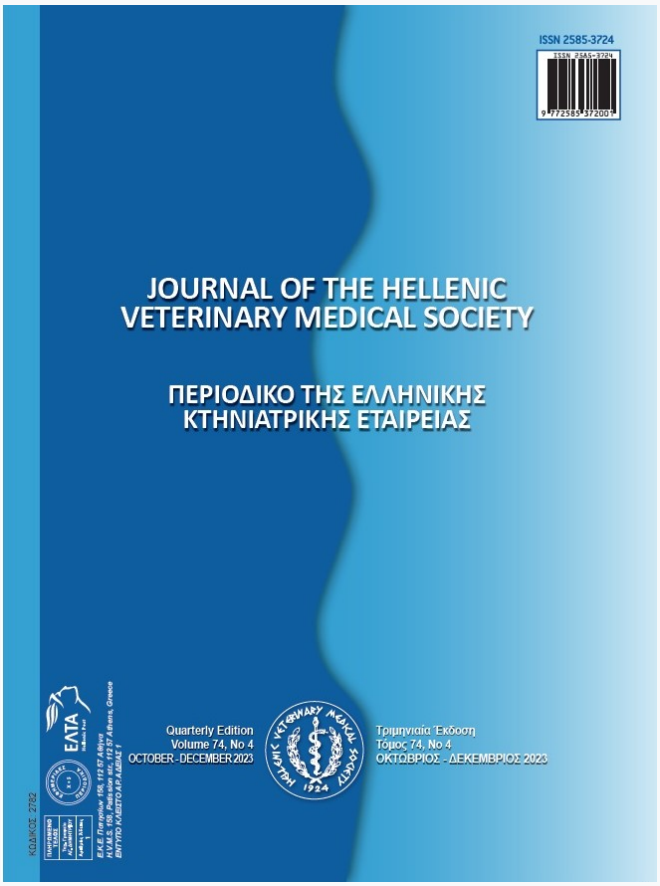

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Research article
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Caecal dilatation and dislocation in 20 dairy cows. A retrospective study

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ABSTRACT: A total of 20 cows with caecal dilatation and dislocation were included in this retrospective study. The aim of the study was to describe the findings of the initial clinical examination, the haematological, biochemical and venous blood gas analysis as well as the therapeutic management and the surgical findings of these cases. A positive simultaneous percussion and auscultation in the right flank as well as rectal palpation of the distended caecum were the most common findings in 90% of the animals. Increased haematocrit, hyperlactateaemia and hyperglycaemia were the most often occurring laboratory findings. Conservative treatment using neostigmine s.c. (0.025mg/kg) was successful in three out of four cases. Surgical therapy including laparotomy in the right flank and typhlotomy was performed in 17 cases. Caecal dilatation (n=9), retroflexion (n=4) and torsion (n=4) were revealed intraoperatively. During surgery in three cows, the caecum had filled once again with fluid content and typhlotomyhad to be repeated. Typhlectomy was not necessary in any of these cows. A relaparotomy due to recurrence of the caecal disorder was not required in any of the cases during hospitalisation. The postsurgical treatment included antibiotics, neostigmine in all cows and fluid therapy in the majority of the animals. Laxative treatment using 250 g sodium sulphate twice daily per os was applied in 10 cases. All cows were discharged from the clinic and returned to the farm.

Keywords: caecal retroflexion; ileus; laparotomy; typhlotomy; cattle

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INTRODUCTION

Caecal dilatation and dislocation (CDD) is a common disorder of the digestive tract in dairy cattle (Nichols and Fecteau, 2018). This disorder can occur in different forms and can cause partial or complete intestinal obstruction (Braun et al., 2012).

It can be presented as caecal dilatation, when the caecum is distended, but still positioned in a physiological caudal direction with the apex reaching the pelvis, as retroflexion, when the distended caecal apex is displaced (folded) in a cranial direction (180° retroflexion), or as torsion, when the caecum is twisted in its longitudinal axis (Nichols and Fecteau, 2018). Caecal torsion occurs more rarely than the other caecal disorders, but it could lead to neurovascular compromise of the caecum due to the tightly stretched ileocaecal fold (Meylan, 2008). In severe cases of caecal retroflexion, with marked gas accumulation, the number of degrees of rotation may reach (or exceed) 360° (Green and Husband, 1996; Steiner, 2004; Nichols and Fecteau, 2018). The term caecal dislocation describes any retroflexion or torsion of the caecum (Steiner, 2004).

The aetiology of CDD remains unclear (Constable et al., 2017). Recent studies reported that hypomotility of the spiral colon (and not of the caecum or proximal loop of the ascending colon), disturbing the physiological transit of ingesta, may play an important role in the pathogenesis of CDD (Devaux et al., 2015; Kunz-Kirchhofer et al., 2010; Stocker et al., 1997).

The therapeutical options include medical treatment using prokinetic drugs (Constable et al., 2017) or the surgical approach, which mainly includes the exteriorisation and emptying of the dilated caecum and the proximal loop of the ascending colon (PLAC) via typhlotomy (Nichols and Fecteau, 2018).

It was the aim of this study to describe the clinical and laboratory findings as well as the therapy of 20 cows diagnosed with caecal dilatation and dislocationwithin a six-year period.

MATERIALS AND METHODS

Medical records from 20 cows with caecal dilatation and dislocation, which were admitted from 1 January 2015 to 30 December 2020 to the Clinic for Cattle of the University of Veterinary Medicine Hannover Foundation, Hannover, Germany were reviewed for this study.

The reported data included signalment, age, reproduction status, history and feed intake, initial clinical and laboratory findings, treatment and outcome. In cases where laparotomy was carried out, the surgical findings were also reviewed.

All cows were clinically examined and blood samples were taken from the jugular vein after clinical examination. Blood gas analysis was performed in nine cases. Caecal torsion or retroflexion was confirmed intraoperatively.

The leukocyte count, red blood cell count, haemoglobin concentration and thrombocyte count were performed in EDTA blood samples using an automatic haematologyanalyser with the electrical impedance method (Celltac-α, MEK-6450, Nihon Kohden, QinlabDiagnostik, Weichs, Germany). The haematocrit level was determined using capillary centrifugation (Hettich Haematokrit centrifuge, Hettich Holding GmbH & Co. oHG, Kirchlengern, Germany).

The following parameters were measured in serum blood samples: total protein, total bilirubin, aspartate aminotransferase (AST), gamma-glutamyltransferase (γGT), glutamate dehydrogenase (GLDH), urea, creatinine, albumin, magnesium, phosphorus, sodium, potassium and chloride using an analyser for clinical chemistry (ABX Pentra® 400, HORIBA Medical, Montpellier, France). The total calcium measurement in serum was performed using a clinical chemistry analyser (Cobas Mira® Plus, Hoffmann La-Roche AG, Basel, Switzerland).

The parameters pH, partial pressure of carbon dioxide (pCO2) corrected for the rectal temperature, actual bicarbonate ($HCO3^-$), base excess (BE), L-lactate and glucose were determined in blood gas capillaries using the EPOC system (EPOC Host and Reader, Siemens Healthineers AG, Erlangen, Germany).

The serum and EDTA blood samples were analysed approximately 12-18 hours after the samples had been taken. The blood gas analysis and haematocrit determination were carried out within five minutes of blood sample collection.

RESULTS

History and signalment

All 20 animals included in the study were Holstein-Friesian cows aged 2.3 to 11 years old (5.6±2.2 years old; mean ± standard deviation). Twelve cows were less than 100 days in milk and eight of these

12 cows were less than 10 days postpartum. One cow was in the last month of gestation. A seasonal occurrence of the disease was not mentioned, as the cases were spread all over the year. Almost all cows originated from different farms except for two cases, which were presented to the clinic with a three-year interval between the admissions. No farmer reported any gastrointestinal disorder of his animals as a herd problem.

The majority of the cows was admitted to the clinic within one day after the occurrence of the first symptoms, such as sudden inappetence and milk yield drop. A severe milk yield drop was reported in 80% of the animals. In two cases, the farmer mentioned colic symptoms before admission to the clinic. One cow had undergone laparotomy and omentopexy one month previously.

Clinical findings

The main findings of the initial clinical examination are summarised in Table 1. Most of the cows were bright and alert. Moderate colic symptoms occurred in three cows and two cows were apathetic. Most of

Table 1. Selected initial clinical findings in 20 cows with caecal dilation and dislocation.

Clinical parameter	Finding	Number of cows
Abdominal contour	physiological	14
	distended ventrally	6
Behaviour	normal	13
	slightly dull	3
	apathetic	2
	moderate colic symptoms	2
Posture	normal	16
	slightly arched back	3
	recumbent	1
Respiratory rate (brpm)	normal (16-28 brpm)	11
	increased (> 28 brpm)	9
Heart rate (bpm)	normal (60 - 80 bpm)	9
	decreased (< 60 bpm)	2
	increased (> 80 bpm)	9
Rectal temperature (°C)	normal (38.3-39.5°C)	15
	decreased (< 38.3°C)	3
	increased (> 39.5°C)	2
Eyeball position in orbit	normal	17
	slightly to moderately sunken	3
Skin turgor	normal	8
	slightly decreased	9
	severely decreased	3
Episcleral vessels	normal	14
	slightly congested	4
	moderately congested	2
Rumen fullness and consistency	normal	7
	moderate	11
	poor	2
Ruminal motility	normal	5
	reduced	12
	absence of ruminal contractions	3
PA/SA on right flank	negative/negative	2
	positive/negative	7
	positive/positive	11
Liver percussion dullness	normal	15
	absent	5

Abdominal wall tension	physiologically soft	9
	slightly increased	10
	moderately increased	1
Faecal output	great amount	13
	small amount	4
	absence of defaecation	3
Faecal consistency	medium porridge-like	8
	runny	3
	watery	4
	firm porridge-like	2
Colour of faeces	olive-green	16
	dark olive	1
Degree of faecalfibre comminution	normal	10
	finely comminuted	7
Position of caecum from the rectum	not palpable	2
	in the pelvis	10
	directly cranial of the pelvis	3
	in the right upper quadrant	5

beats per minute (bpm), breaths per minute (brpm), percussion auscultation (PA), swinging auscultation (SA).

the cows had a physiological posture during the examination. Four cows stood with an arched back and the pregnant cow in late gestation was recumbent. A total of 30 % of the cows were inappetent. The body condition score varied among the cows from 2.25 to 4.0 (3.0±0.5). Thirteen cows were clinically dehydrated. The tachycardiac cows (n=9) had a heart frequency ranging from 84 to 104 beats per minute (bpm). Distention of the ventral abdominal contour was mentioned in six cases. The rectal temperature varied from 37.5 to 39.7 °C (38.7±0.6 °C).

The simultaneous percussion auscultation in the right flank was positive in 90% of the cows, revealing a tympanic hollow sound or steel-band sound caudal to the last rib and on the transverse processes of the lumbar vertebrae. Occasionally the ping sounds extended caudally to the right tuber coxae. By swinging auscultation, a splashing sound was induced on the right side in 55% of the cases. The liver percussion field was clearly detected in 75% of the cows.

Seven out of 20 cows had a small amount (n=4) or absence (n=3) of faeces in the rectum. The plant fragments in faeces were finely comminuted in 40% of the cows. The distended caecum was rectally palpable in 18 out of 20 cases. The dome-shaped (gas-filled) distended caecal apex was palpable directly cranial (n=4) or into the pelvic cavity (n=9). In five cases, the distended caecum was identified palpatorically in the right upper quadrant. The twisted area of the caecum was palpable in one case.

Mild ketosis (mild ketonuria) was found in three cases and two other cows hadgrade 1 metritis (Sheldon et al., 2009).In two cases, chronic mastitis was diagnosed. One animal was lame because of a sole ulcer and interdigital hyperplasia.

Haematological findings

Selected haematological and biochemical findings (n=20) as well as the results of the blood gas analysis (n=9) are summarised in Table 2. Most of the cows (n=11) had an elevated hematocrit level. The activity of the liver enzymes was only slightly elevated in most of the cows. Four out of five cows with hypocalcaemia had only a slightly decreased total calcium value (1.76-2.05 mmol/L).

Only 20% of the study animals were hypochloraemic with values ranging from 75 to 85 mmol/L, and a lower potassium value than normal was measured in five cases with values from 2.82 to 3.44 mmol/L. Metabolic alkalosis was revealed in only two cows. However, hyperlactataemia was found in eight out of nine cows before surgery. Hyperglycaemia was another common finding in 89% of the cases.

Treatment

The treatment decision (conservative or surgical) was at the surgeon's discretion and was based on the initial clinical findings. The cows which were treated conservatively were in a good general condition, the faecal output was not entirely absent and caecal tor-

Table 2. Selected laboratory findings in 20 cows with caecal dilation and dislocation.

Parameter (Unit)	n	Mean	SD	Min	Max	Normal range
Haematocrit (%)	20	35.7	6.7	21.3	50.0	25-35
Total protein (g/L)	20	70.4	7.9	56.0	85.0	60-80
Leucocyte count (cells/μL)	20	11000	3900	5300	17100	5000-10000
RBC (*10^{6}cells/μL)	20	6.8	1.2	4.6	9.4	6-8
Haemoglobin (g/dL)	20	10.5	2.0	6.4	14.3	8.0-14.0
Thrombocytes (cells/μL)	20	346000	121000	213000	637000	200000-800000
Bilirubin (μmol/L)	20	7.4	3.9	2.5	16.4	<7.0
AST (U/I)	20	121	62	57	292	<100
γGT (U/I)	20	31	15	16	87	<33
GLDH (U/I)	20	13.2	6.7	4.31	25.30	<14
Urea (mmol/L)	20	7.7	3.6	1.99	14.39	<8
Creatinine (μmol/L)	20	83.8	31.4	58.6	191	<150
Albumin (g/L)	20	32.8	3.1	26.3	37.5	30-40
Total calcium (mmol/L)	20	2.11	0.25	1.39	2.54	2.1-3.0
Magnesium (mmol/L)	20	0.98	0.16	0.62	1.27	0.7-1.2
Phosphorus (mmol/L)	20	1.75	0.55	0.82	2.76	1.1-2.4
Sodium (mmol/L)	20	138	4	130	150	135-145
Potassium (mmol/L)	20	4.01	0.70	2.82	5.64	3.5-4.5
Chloride (mmol/L)	20	92	7	75	105	90-110
pH	9	7.39	0.06	7.318	7.481	7.35-7.45
Bicarbonate (mmol/L)	9	27.4	4.3	23	34.8	21-28
BE (mmol/L)	9	2.8	5.1	-2.4	11.6	-2-3.0
L-lactate (mmol/L)	9	4.32	3.14	0.3	10.7	0.56-1.39
Glucose (mg/dL)	9	169	61	99	253	74-100
pCO2 (mm Hg)	9	45.4	3.4	39.6	49	35-48

red blood cell count (RBC), aspartate aminotransferase (AST), gamma-glutamyltransferase (γGT), glutamate dehydrogenase (GLDH), base excess (BE), partial pressure of carbon dioxide (pCO2), standard deviation (SD), minimum (Min), maximum (Max).

sion or retroflexion was not suspected according to the rectal findings. In addition, the perioperative and postoperative medical therapy was at the discretion of the clinic ward round.

Conservative treatment

The conservative treatment included a single application of neostigmine (0.025mg/kg; s.c.) followed by walking the cow for at least 15 minutes. The conservative therapy was successful in three out of four cases, which was characterised by a great amount of watery arched-shaped faecal output and thereafter the absence of the dilated viscus rectally. The medical treatment was continued for one to three days including neostigmine s.c. every eight hours (0.02mg/kg) or every 12 hours (0.025mg/kg) and 250g sodium sulphate per os twice daily. Two animals received fluid therapy per drench via an orogastric tube and calcium bolus orally. The cow that did not respond to the medical treatment underwent laparotomy.

Operative treatment

A right flank laparotomy was performed in 17 animals after distal paravertebral block and infiltration anaesthesia at the site of incision in the right flank with 180 mL procaine hydrochloride with epinephrine. Laparotomy was performed in all cows in a standing position, excluding the one heavily pregnant cow, which was recumbent on the day of surgery. In accordance withpain management, meloxicam (0.5 mg/kg; s.c.) was administered before surgery in each cow. The animals with colic symptoms before surgery and those with extremely tense dilated intestinal loops during caecal exteriorisation (n=6) were administered metamizol (40 mg/kg)intravenously.

Surgical findings

Of the 17 cows which underwent surgery, the peritoneal fluid was slightly to moderately increased in eight cases, slightly reddish and odourless. The relaparatomised cow had slight fibrinous admixture in the abdominal cavity. On exploring the abdominal

cavity, caecal dilatation with the caecal apex pointed caudal (n=9), retroflexion (n=4) or torsion (n=4) was revealed. In all the cases (n=17), typhlotomy was performed.

The caecal fluid content varied from 6 to 20 L with also a variable amount of gas (Figure 1). It was drained through an approximately 3-4 cm incision at the lowest part of the apex (Figure 2). In some cases (n=3), sandy content (admixture) was also emptied through the apex incision.

The caecal incisional wound was sutured twice with inverted Cushing pattern (Polyglycolic Acid Su-

Figure 1. An exteriorised, severely dilated caecum.

Figure 2. The apex incision of an exteriorised caecum after emptying the fluid content. The incisional wound was cleaned and turned upwards to be sutured.

ture 2/0). The exteriorised caecum was lavaged with 0.5% povidone iodine solution before being replaced in the abdominal cavity. The ansaproximalis coli was highly filled with fluid and gas in eight cows, which had to be massaged out and drained through the caecal incision. In three cases, the caecum was exteriorised once again, as it was refilled with fluid ingesta after being replaced in the abdominal cavity and typhlotomy was repeated. The fluid intestinal content was emptied once again through the initial caecal incision which was resutured with the same technique. In one case, decompressing the severely dilated and gas-filled ansaproximalis coli with a needle attached to a tube proved necessary. Except for a single case where a slightly blueish spot at the torsion area near the plica ileocaecalis was noted, there were no devitalised intestinal areas, and therefore, in none of the cases was typhlectomy performed. The abomasal sandy content was palpable in six cases without abomasal dilatation. Chronic, slightly local peritoneal adhesions of the greater curvature of the abomasum or of the reticulum were found in two cows.

In all cows with laparotomy, the abomasum was indirectly fixed through a modified Dirksen omentopexy technique (Dirksen, 1967) with a plastic plate placed on the great omentum 5 to 10 cm caudal to the pylorus. This was then sutured with non-absorbable polyamid suture (USP 8) on the inner side of the abdominal wall without using a plastic knob subcutaneously (Heimberg and Scholz, 2002).

Before suturing the peritoneal cavity, 1-2 litres of 0.5% povidone iodine solution werea dministered into the peritoneal cavity. The abdominal wall was closed in three layers. Procaine benzylpenicillin (20-30 mL; 300 mg/mL) was administered locally between the muscle layers.

In the one case which had undergone omentopexy surgery in the past, the omentum was rope-shaped, distended, but still fixed to the abdominal wall. In this case, the omentum was separated from the peritoneum, and omentopexy was reperformed approximately 5 cm higher than previously.

Post-surgical treatment and outcome

Each cow which underwent surgery received antibiotics. Most of the cases (n=14) were treated with amoxicillin s.c. once daily. Two cows received trimethoprim-sulfonamide (24 mg/kg daily) after the surgery and one case was treated with enrofloxacin (5 mg/kg daily). Antibiotics were applied in most of the cases for five days.

The prokinetic postoperative treatment included neostigmine s.c. in all cows every eight hours (0.02 mg/kg) or every 12 hours (0.025 mg/kg). Additionally, 250 gsodium sulphate was applied per os twice daily as a laxative in 10 cows. The prokinetic and laxative treatment in most of the cases was continued for one to two days after surgery and was at the discretion of the clinic ward round. Except for concentrated feed, which was mostly not offered for 24 hours after the operation, the animals were supplied with hay *ad libitum* and maize silage based on milk yields during the hospitalisation period.

During or directly after surgery, 12 cows received intravenous fluid therapy via drip infusion (10 L-20 L 0.9% NaCl solution containing an additional KCl 30 mmol/L) and three of them were drenched additionally directly postoperatively via an orogastric tube with 30 L water and 100-150 g KCl. One animal received only oral fluid therapy directly after surgery. The calcium deficiency which occurred in some cows (n=5) was compensated via drip infusion (boroglyconic calcium) or calcium bolus administration. On the first postoperative days, fluid therapy was continued via drench (n=12) rather than infusion (n=4). Depending on the electrolytes imbalances, the cows were drenched postoperatively once per day with 30 L water and 150 gNaCl or KCl. No case required relaparotomy.

In two single cases, a slightly distended intestinal loop (caecum in one case and PLAC in the other) was rectally palpable during the postoperative period. However, both cows had undisturbed faecal output. The rectal findings of these two animals were completely normal after five and eight days, respectively.

The feed intake and ruminal motility were progressively normalised and the milk yield gradually increased in lactating cows after surgery leading to a good prognosis in 18 out of 20 cows. The hospitalisationduration varied from 4 to 19 days (9±4 days) among these cases. However, wound complication with abscess formation occurred in one cow after typhlotomy and an intensive and prolonged claw treatment was postoperatively required in another case. These two individual cases required a longer hospitalisation period.

DISCUSSION

Most of the cows with CDD in our study (17 out of 20) underwent laparotomy on the right flank and typhlotomy, and only three were treated successfully conservatively (15 %). The surgical treatment was the predominant therapy also in other studies which included more cases (Fubini et al., 1986; Braun et al., 1989; Braun et al., 2012), whereas the percentage of cattle treated conservatively varied between 11% (Braun et al., 1989) and 21.4% (Fubini et al., 1986).

The decision to treat a cow with CDD conservatively is based on a physiological or slightly disturbed general condition, the presence of faecal output and the rectal findings (no suspicion of caecaltorsion or retroflexion) (Braun et al., 2012). However, caecal torsion in some cases could not be ruled out through rectal palpation (Braun et al., 1989). In our retrospective study, a caecal twist had been identified rectally in only two out of four cases with caecal torsion.

In some cases with retroflexion, the caecum may not be palpable or can only be reached with the fingertips (Braun, 2005). In the present study, the distended caecum was rectally palpable in 90% of the cows, except for two out of three cases with caecal retroflexion which were diagnosed during surgery. Similar results have been reported in previous studies where the dilated caecum was rectally palpable in 87.9% of the cases (Braun et al., 2012). In another study, a rectally palpable viscus (apex) was found in 78% of the cattle with caecal dilatation and in 43% of cattle with caecal retroflexion (Fubini et al., 1986). No sonographic examination had been performed before laparotomy of the animals in our study, even though this could have been helpful before the decision of an exploratory laparotomy. The caecal disorders can be presented sonographically as previously reported (Braun et al., 2002).

In cases of caecal devitalisation or recurrence of CDD, typhlectomy is indicated (Steiner et al., 1992; Nichols and Fecteau, 2018). None of the 17 cows which were treated surgically in our study required typhlectomy. In a previous study, caecal amputation was performed in 12.7% of the animals during first surgery and in most of the cows which under wentre-laparotomy because of recurrence of the caecal disorder (Braun et al., 2012).

All the cows in our study were discharged from the clinic with a normal general condition, appetite and physiological rectal findings. In the literature, 10% recurrence of the caecal disorder was described within the first week and a further 12.5% within 14 months after surgery (Steiner et al., 1992). None of the cows in our study had to be readmitted to the clinic because of recurrence of a caecal disorder. Nonetheless, because a follow-up survey was not performed, we could not be sure about the long-term survival on the farm, which is a limitation of this study.

Cows with caecal dilatation have mostly normal haematological and biochemical values (Meylan, 2008). Nevertheless, in severe or longer lasting cases ofcaecal disorder, the prolonged obstruction at the ileocaecocolic orifice or the compression on the duodenum may lead to abomasal reflux and hypochloraemic hypokaliaemic alkalosis (Smith, 1987; Fubini, 1990).

In our study, four cows had hypochloraemia and five were hypokaliaemic. Therefore, as hypokaliaemia can cause atony of the gastrointestinal tract, the oral application of KCL should be included in the fluid therapy (Constable et al. 2013). The hyperlactatetaemia found in eight out of nine animals was probably caused by peripheral or local tissue hypoperfusion (Boulay et al., 2014). The hyperglycaemia measured in most of the animals was probably stress induced (Anderson et al., 1993). The increased haematocrit levels measured in 11 cows was most likely the result of dehydration. The activity of the liver enzymes was in most cases only slightly elevated (Table 2), probably because of the immediate admission to the clinic after the first symptoms had occurred, thus possibly avoiding excessive lipomobilisation.

Neostigmine was administered as a prokinetic drug in cases which were conservatively managed as well as two to three times daily postoperatively. The duration depended on the individual clinical response of the animals. The application of neostigmine diluted via intravenous drop infusion has been reported in Swiss studies (Braun et al., 2012), which required intensive monitoring of clinical parameters of the individual animals and a steady drip infusion tempo.

Although bethanechol used as a prokinetic in the treatment of cows with CDD has been recommended (Steiner et al., 1995; Constable et al., 2017), the use of bethanechol is not allowed in food producing animals in the European Union (Commission Regulation (EU) No. 37/2010).

As long as the aetiology of CDD remains unclear, the occurrence of this disorder may not be essentially

prevented. Thus, the role played by clinical veterinarians in promptly diagnosing and therapeutically managing such conditions remains important.

CONCLUSIONS

Caecal dilatation and dislocation could be diagnosed clinically in most of the cows. The conservative treatment could be performed in mild cases. However, most of the cows should undergo laparotomy and typhlotomy. The majority of the cows did not have severely abnormal haematological and biochemical findings. Postoperative treatment includes antibiotics, prokinetics and fluid therapy. The prognosis is good in most of the cases.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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