



Caudal vena cava thrombosis in cattle in Southern Brazil: clinical and pathological aspects of 30 cases

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ABSTRACT: Hemoptysis associated with respiratory disorders are some findings of caudal vena cava thrombosis (CVCT) in cattle. Nevertheless, CVCT may be accompanied by a broad spectrum of clinical signs and gross lesions. This study reported the frequency of CVCT in cattle necropsied in Southern Brazil and described its clinical signs, as well as pathological findings. From a total of 1,976 *postmortem* examination reports in cattle in Southern Brazil, there were 30 cases (1.5%) of CVCT. In the clinical evaluation, the main clinical course was chronic (13/30), followed by peracute (7/30), acute (4/30), and subacute (5/30). Hemoptysis (17/30), dyspnea (8/30), and anorexia or hyporexia (7/30) were the most reported clinical signs. Septic thrombophlebitis of the caudal vena cava (24/30), hepatic abscesses (24/30), pulmonary hemorrhage (23/30), and embolic pneumonia (19/30) were the main lesions observed at the necropsy. We concluded that CVCT is a relevant cause of death in bovines from Santa Catarina state, mainly in adult dairy cows. The disease is characterized by a wide range of clinical signs and lesions, requiring attention from veterinarians for the correct diagnosis. Furthermore, the association between the clinical history, clinical signs, and lesions is essential for the diagnosis of CVCT in cattle.

Keywords: hepatic abscesses, embolic pneumonia, vena cava, pulmonary hemorrhage.

Tromboembolismo da veia cava caudal em bovinos no Sul do Brasil: aspectos clínicos e patológicos de 30 casos

RESUMO: Hemoptise associada a sinais respiratórios são achados típicos de tromboembolismo da veia cava caudal (TVCC) em bovinos. Todavia, o TVCC pode estar acompanhado de um amplo espectro de sinais clínicos e lesões macroscópicas. Esse estudo tem por objetivo relatar a frequência do diagnóstico de TVCC em bovinos necropsiados no sul do Brasil e descrever os sinais clínicos, assim como achados patológicos dessa condição. De um total de 1.976 exames *post-mortem* realizados em bovinos no Sul do Brasil, 30 casos de TVCC foram diagnosticados (1,5%). No exame clínico, o principal curso clínico observado foi crônico (13/30), seguido do hiperagudo (7/30), agudo (4/30) e subagudo (5/30), em um caso o histórico clínico não foi fornecido. Hemoptise (17/30), dispnéia (8/30) e anorexia ou hiporexia (7/30) foram os sinais clínicos mais comumente relatados. Tromboflebite séptica da veia cava caudal (24/30), abscessos hepáticos (24/30), hemorragia pulmonar (23/30) e pneumonia embólica (19/30) foram as principais lesões observadas na necropsia. Com esse trabalho conclui-se que TVCC é uma causa relevante de morte em bovinos no estado de Santa Catarina, principalmente em vacas leiteiras adultas. A doença é caracterizada por uma variedade de sinais clínicos e lesões, necessitando de atenção dos veterinários para o correto diagnóstico. Ainda, a associação entre o histórico clínico, sinais clínicos e lesões de necropsia é essencial para o diagnóstico de TVCC em bovinos.

Palavras-chave: abscessos hepáticos, pneumonia embólica, veia cava, hemorragia pulmonar.

INTRODUCTION

Caudal vena cava thrombosis (CVCT) is a condition of cattle, presumably as a consequence of ruminal acidosis where bacteria enter the bloodstream and arrive in the liver through the portal system, resulting in the development of abscesses in the hepatic parenchyma (GUDMUNDSON et al., 1978). Frequently, hepatic abscesses erode the main hepatic veins and the caudal vena cava, releasing

septic emboli into the bloodstream and resulting in embolic pneumonia. These emboli lodge in the pulmonary vessels, causing vasculitis, vascular hypertension, and aneurysms (MILLS & PACE, 1990; BRAUN, 2008; SCHILD et al., 2017). When a lung vessel is eroded and ruptures, pulmonary hemorrhage and hemoptysis may occur (MOTTA et al., 2016). CVCT affects cattle of any breed, sex, or age; although, reports in animals under one year of age are rare and most of the cases are described in

adult lactating cows fed with highly fermentable diets (WILINS & WOOLUMS, 2015).

There are few published studies worldwide regarding the occurrence of CVCT and its clinical and pathological patterns, and the reports in Brazil are scarce. Therefore, this study described the frequency, clinical signs, and pathological findings of CVCT in cattle necropsied in Southern Brazil.

MATERIALS AND METHODS

The database of the Laboratory of Veterinary Pathology (LVP) at the Instituto Federal Catarinense (IFC) *Campus* Concórdia was searched manually for diagnosed cases of CVCT in cattle, from March 2013 to April 2022. Field necropsies were performed by the LVP IFC-*Campus* Concórdia, or by veterinarians in which samples were submitted for histopathological examination at the same institution. At necropsy, gross changes were recorded, representative organ samples were collected, fixed in 10% formalin solution, routinely processed for histopathology, and stained using hematoxylin and eosin. *Postmortem* examination reports of the selected cases were reviewed, and information compiled included clinical signs, evolution of the clinical course, epidemiologic, and gross findings. In most cases, clinical signs were reported by the attending veterinarians or by the owners of the cattle. Additionally, cases were divided according to DIVERS & PEEK'S (2008) classification for clinical diseases in cattle, where the duration of the clinical signs is classified as peracute (0 to 24 hours), acute (24 to 96 hours), subacute (4 to 14 days) and chronic (more than 14 days).

Cases were diagnosed as CVCT when a septic thrombus was seen in the caudal vena cava or major hepatic veins, associated with pulmonary lesions of embolic pneumonia and/or pulmonary hemorrhage were seen, according to lesions described by GUDMUNDSON (1978). Lastly, a sample of a hepatic abscess from case 30 was submitted to microbiological culture where identification was carried out through colony morphology and biochemistry tests (QUINN et al., 2011).

For this study, statistical analysis was carried out using Microsoft Excel® program. It was estimated the frequencies concerning the geographical distribution (state), form of death (spontaneous or euthanasia), breed, duration of the clinical course, clinical signs, and *postmortem* findings of the affected cattle. Also, it was defined the values related to the mean and median age of the animals.

RESULTS

Postmortem examination samples of a total of 1,976 cattle of all ages, sex, and breeds were analyzed from March 2013 to April 2022. Thirty cases out of the total were diagnosed as CVCT, representing 1.5% of the causes of death in bovines from the studied geographic area. Out of the 30 cases, 27 (90%) were diagnosed through necropsies conducted by the LVP. The three (10%) remaining cases were represented by tissue sets referred to the LVP, collected during necropsies conducted by field veterinarians. In these cases, the condition was confirmed by histopathological exams in association with the provided clinical history and necropsy findings.

Twenty-eight cases (93.3%) were from the state of Santa Catarina, mainly from municipalities in the west region of the state, such as Concórdia, where the LVP is located; and neighboring towns. Two cases (6.7%) were from the state of Rio Grande do Sul. Animals died spontaneously (22/30; 73.3%) or were submitted to euthanasia (8/30; 26.7%) due to their poor clinical prognosis. Only females were affected in this study and the age ranged from 1 to 10 years, with mean and median age values of 4.5 years and 4 years, respectively. Twenty-nine of the 30 cases (96.7%) were diagnosed in dairy cows and breeds included Holstein-Friesian (24/30; 80%), Jersey (4/30; 13.3%), and Holstein-Friesian x Jersey crossbred (1/30; 3.3%). The only beef cattle case (bovine 5) was an Angus cow (1/30; 3.3%).

Data regarding the clinical signs and clinical courses of each case are depicted in table 1. According to the clinical classification proposed by DIVERS & PEEK (2008), seven animals (23.3%) showed a peracute presentation, four animals (13.3%) had an acute presentation, five animals (16.7%) a subacute presentation, and thirteen animals (43.3%) presented a chronic form. In one case (1/30), the clinical course was not provided.

The most frequently observed clinical sign reported in the medical histories was hemoptysis (17/30; 56.7%) (Figure 1A). Regarding the animals that showed this clinical sign, the period from the beginning of this presentation to the death varied from some minutes to a few hours (8/17; 47.1%), from two to five days (5/17; 29.4%), and, in four cases, from 10 to 20 days (23.5%).

Other clinical signs included dyspnea (8/30; 26.7%), anorexia or hyporexia (7/30; 23.3%), weight loss (6/30; 20%), cough (6/30; 20%), apathy (4/30; 13.3%), recumbence (2/30; 6.7%), hyperthermia (2/30; 6.7%), tachypnea (2/30;

Table 1 - Clinical signs and clinical courses of cases of caudal vena cava thrombosis in cattle.

Case	Clinical signs	Clinical course
1	Apathy and anorexia	Peracute
2	Anorexia, fever, weight loss, and apathy ^a	Chronic
3	Sudden death	Peracute
4	Ruminal atony, cough, dyspnea, and hemoptysis	Acute
5	Dyspnea and hemoptysis	Peracute
6	Apathy, cough, and hemoptysis ^a	Chronic
7	Hemoptysis	Peracute
8	Hemoptysis	Peracute
9	NI ^b	NI ^b
10	Purulent nasal discharge, dyspnea, and hemoptysis	Chronic
11	Hemoptysis, anorexia, and agalactia	Chronic
12	Found dead with hemoptysis	Peracute
13	Hemoptysis ^a	Acute
14	Apathy, pulmonary rales	Subacute
15	Dyspnea and later found dead with hemoptysis	Chronic
16	Hemoptysis	Subacute
17	Weight loss, fever, and hemoptysis	Chronic
18	Hyporexia, weight loss, and hemoptysis ^a	Chronic
19	Diarrhea, anorexia, and recumbence	Acute
20	Weight loss, cough, and hemoptysis ^a	Subacute
21	Hemoptysis and weight loss	Chronic
22	Abdominal distension and dyspnea	Peracute
23	Dyspnea, tachypnea, and cough ^a	Chronic
24	Weight loss, apathy, anorexia, and cough	Chronic
25	Apathy	Chronic
26	Hypogalactia and tachypnea	Subacute
27	Hemoptysis and dyspnea ^a	Subacute
28	Difficulty in getting up and walking	Chronic
29	Dyspnea, and hemoptysis ^a	Chronic
30	Anorexia, recumbence, vocalization, and dyspnea	Acute

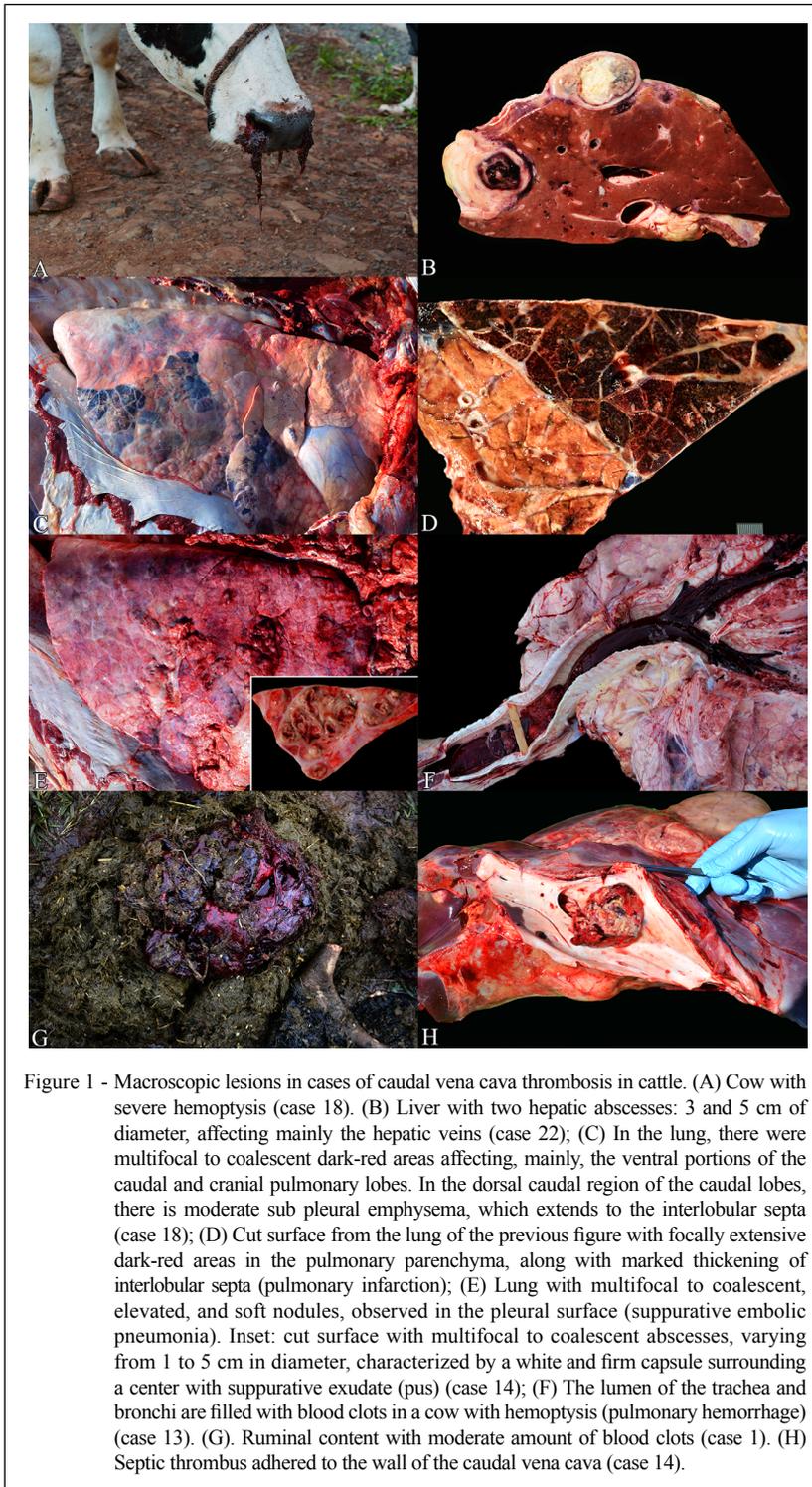
^a Euthanized. ^b Not informed.

6.7%), and hypogalactia (2/30; 6.7%). Pale mucous membranes, pulmonary rales on auscultation, vocalization, ruminal atony, diarrhea, acute abdominal distension, and difficulty in standing up and walking were described once each (3.3% each). Information on the clinical history and clinical signs from bovine 9 was not provided.

Data concerning the presence of main gross lesions of each case are depicted in table 2. The most frequent macroscopic finding was one or multiple large abscesses of variable size in the hepatic parenchyma and/or affecting major hepatic veins (28/30; 93%) (Figure 1B). In the two remaining cases, the occurrence of a hepatic abscess was not informed in the report. In the bovine where the content of a hepatic abscess was submitted to bacterial culture, *Trueperella pyogenes* was isolated.

The second most frequent lesion was pulmonary hemorrhage (23/30; 76.7%), characterized by focally extensive or multifocal to coalescent well-demarcated dark-red areas (Figures 1C and 1D) and, less commonly, as large encapsulated nodules of up to 20 cm in diameter, containing blood clots in the center. Embolic pneumonia (Figure 1E) was commonly seen (19/30; 63.3%) and characterized by multifocal nodular areas, which contained a connective tissue capsule filled with a large amount of suppurative yellowish material (abscesses) of varying size, randomly scattered in all pulmonary lobes. Large amounts of blood clots in the tracheal lumen (Figure 1F) (10/30; 33.3%) and mixed with the rumen ingesta (Figure 1G) (6/30; 20%) were also observed.

In 24 cases (80%), one of the abscesses was near the caudal vena cava insertion into the



liver, resulting in a septic thrombus adhered to the endothelium of the vessel. In the remaining cases, abscesses were in the hepatic parenchyma, near a large hepatic vein. The septic thrombi in the lumen

of the caudal vena cava or major hepatic vessels were characterized by a yellow, raised, friable material adhered to the endothelium and variably occluding the lumen of these vessels (Figure 1H).

Table 2 - Main macroscopic alterations in cases of caudal vena cava thrombosis in cattle.

Case	Gross lesions ^a				
	Septic thrombus ^b	Hepatic abscesses	Embolic pneumonia	Pulmonary hemorrhage	Clots in the trachea/rumen
1	+	+	+	+	+/+
2	+	+	+	-	-/-
3	-	+	-	+	-/-
4	NI	NI	+	+	NI/NI
5	NI	NI	-	+	-/-
6	+	+	+	+	-/+
7	+	+	+	+	+/-
8	-	+	-	+	+/+
9	NI	+	-	+	-/-
10	+	+	+	-	-/+
11	+	+	+	+	-/-
12	+	+	-	+	-/-
13	+	+	-	+	+/-
14	+	+	+	+	-/-
15	+	+	-	+	+/-
16	+	+	+	+	+/-
17	+	+	+	+	-/-
18	+	+	-	+	+/-
19	+	+	+	-	-/-
20	-	+	+	+	+/+
21	+	+	+	+	+/-
22	+	+	-	+	-/-
23	+	+	+	-	-/-
24	+	+	+	-	-/-
25	+	+	+	-	-/-
26	+	+	+	+	-/-
27	+	+	+	+	-/-
28	+	+	+	+	-/-
29	+	+	-	+	-/-
30	+	+	-	-	-/-

^a Classified as present (+), absent (-) or not informed (NI). ^b Septic thrombus affecting the caudal vena cava or major hepatic vessel.

Lesions observed in fewer animals included chronic hepatic passive congestion (3/30; 10%), marked pulmonary edema (2/30; 6.7%), and right atrioventricular valvar endocarditis (2/30; 6.7%). Right atrium mural endocarditis, ascites with mesocolon edema, an abscess in the reticulum wall (8 cm in diameter), and an adhesion involving the reticulum wall, diaphragm, and liver were observed in one case each, suggested to be from a traumatic reticuloperitonitis (1/30; 3.3% each).

DISCUSSION

In our study, CVCT represented 1.5% of the causes of death in cattle of all ages. Although this frequency seems low, regarding 1.554 diagnoses in

cattle by our lab from 2013-2020, 25 (1.6%) were CVCT, which represented the 13th most common diagnosis among more than 250 conditions diagnosed in that period (PEROSA et al., 2022).

In Brazil, reports of CVCT are scarce in the literature. In a study regarding 6.706 diagnoses in cattle in Southern Brazil, including *postmortem*, biopsies, and slaughterhouse samples, only four cases were diagnosed as CVCT, showing a low frequency of 0.06% (LUCENA et al., 2010). Other report in Brazil by MOTTA et al. (2016) described CVCT as an unusual condition. These studies contrast with our findings, where the condition was seen as a relatively common disease in the Western Santa Catarina state, representing an important cause of death in cattle. Most of our cases of CVCT (96.6%)

was seen in adult dairy cows because they represent most of our casuistic, thus this not represents a breed or production class predisposition.

All bovines were female, and the mean and median ages were 4.5 and 4 years, respectively, corresponding to lactating cows. The LVP is located in a region of Santa Catarina state that has many milk farms, consequently most of our cases were in adult dairy cattle. This distincts to the findings of GUDMUNDSON (1978) who conducted a study, predominantly, in feedlot cattle and in slaughterhouses, thus the cases were mostly seen in beef cattle. However, the author pointed out that there was no breed predilection as we highlight in our cases.

The most prevalent clinical presentation was chronic (43.3%) followed by peracute (23.3%), whereas the acute (13.3%) and subacute (16.7%) showed lower levels. In our study, the chronic presentation lasted for two weeks to up to three months. In this form, clinical signs included anorexia with weight loss, apathy, recumbence, dyspnea, cough, and hemoptysis. It is important to point out that the chronic presentation of CVCT is not commonly reported in the literature. Additionally, clinical signs described by other studies which were not reported in our case series include bruxism, jugular vein distention and pulsation, hypogalactia, and selective eating pattern (GERSPACH et al., 2011; SIMPSON et al., 2012; STRAPASSON et al., 2021). However, these clinical signs could not be excluded in our study, since the medical history in some cases was not complete.

In the acute presentation (1-7 days of clinical course), clinical signs included anorexia, cough, hemoptysis, ruminal atony, diarrhea, recumbence, and vocalization. A similar acute presentation was previously reported, associated with weakness (SCHILD et al., 2017) or pale mucous membranes, apathy, hypogalactia, hyperthermia, tachycardia, tachypnea, positive jugular pulse, and sternal recumbence with the head turned into the flank (MOTTA et al., 2016).

In this study, the most prevalent clinical sign was hemoptysis. Other common clinical signs observed in our study had already been described in other reports, such as anorexia or hyporexia, apathy, loss of body condition, tachypnea, cough, dyspnea, agalactia, pulmonary rales on auscultation, recumbence, and hyperthermia (BRAUN, 2008; SIMPSON et al., 2012; MOTTA et al., 2016; SCHILD et al., 2017). Diarrhea was a clinical sign reported in one of our cases, but not cited in the literature.

Hemoptysis is defined as coughing up blood, usually with the hemorrhage originating in the lungs (CONSTABLE et al., 2017). In our study it

was reported, in the clinical histories, that 17 animals showed hemoptysis, but only six presented cough. However, the cough should not be discarded from the remaining animals as the owners and/or clinician veterinarians may have lacked the observation and/or the report of this clinical sign. Melena is considered a common finding, as the animal may swallow the blood from the hemoptysis (WILINS & WOOLUMS, 2015). Although hemoptysis was the most common clinical sign, in none of our cases melena was reported in the medical history. We found blood in the digestive system, mainly in the rumen, only in the cases with severe hemoptysis and death due to hypovolemia.

Pulmonary hemorrhages, hepatic abscesses, septic thrombi adhered to the endothelium of the caudal vena cava and embolic pneumonia were the most prevalent and important macroscopic findings in our study as described elsewhere (BRAUN, 2008; MOTTA et al., 2016; SCHILD et al., 2017). In cases of extensive acute pulmonary hemorrhage, death usually occurs due to hypovolemic shock, whereas in animals with embolic pneumonia as the main lesion, death may occur due to sepsis, associated with respiratory insufficiency (DIVERS, 2008). Also, the observation of blood clots in the trachea and in the ruminal content was secondary and proportional to the severity of the pulmonary hemorrhage.

In three cases the thrombus compromised the blood flow from the caudal vena cava, and may have led to a passive hepatic congestion, a lesion already reported (MOTTA et al., 2016). In one bovine, the congestion may have caused a portal hypertension, increasing the hydrostatic pressure into the portal hepatic system, resulting in ascites, as well as edema of the mesocolon (BRAUN et al., 2007).

Two animals died due to acute respiratory insufficiency as a consequence of marked pulmonary edema, without pulmonary hemorrhages nor embolic pneumonia. In these cases, microemboli released from the thrombus into the bloodstream results in the generation of toxic oxygen radicals and proteases which injures the endothelial cells of the lungs, increases vascular permeability, and results in the accumulation of fluids (MALIK, 1990). This alteration was reported in four out of ten cases of CVCT in other study in northeast Brazil (COUTINHO et al., 2021). Additionally, SIMPSON et al. (2012) reported a cow with CVCT and clinically diagnosed with pulmonary edema, thus being treated with antidiuretics. However, the animal was euthanized once other clinical signs persisted even after the treatment.

Although ruminal acidosis is the main cause of CVCT (GUDMUNDSON et al., 1978),

less commonly, this condition has been reported as secondary to traumatic reticuloperitonitis (GERSPACH et al., 2011) and pododermatitis (SIMPSON et al., 2012). In one of our cases, the origin of the hepatic abscesses was suggested to be an abscess in the reticulum wall, possibly the result of a previous traumatic reticulitis, similarly to a reticuloperitonitis (SCOTT, 2013). Other case presented with an adhesion involving the reticulum wall, diaphragm, and liver, also suggesting a traumatic reticuloperitonitis. In a traumatic reticulitis or reticuloperitonitis, a foreign body, most commonly a wire or nail, punctures the reticulum wall and inserts bacteria from the forestomach content into the mucosa and blood vessels of the organ, which is then drained to the liver (SOUZA et al., 2021).

Determination of the bacteria involved would be appreciated to state if the same agents were present in the different lesions, such as the hepatic abscesses and the vena cava thrombus, embolic pneumonia, and valvar endocarditis. Unfortunately, bacterial isolation was available only in one case during this study, where *Trueperella pyogenes* was isolated. Many bacteria may be involved, but the main microorganisms reported are *Fusobacterium necrophorum*, *Trueperella pyogenes* (IKAWA, 1987; MOTTA et al., 2016), *Staphylococcus* spp., *Streptococcus* spp., and *Escherichia coli* (WILINS & WOOLUMS, 2015).

Diagnosis of CVCT is reached through clinical signs associated with a history of highly fermentable diet feeding or past diet changes without previous adaptation that could have caused a subacute ruminal acidosis (BRAUN, 2008). Conversely, during necropsy, clinical history may not be presented or it may lack important information. Several non-specific clinical signs may or may not occur concomitantly, which could make the diagnosis challenging (BRAUN et al., 1992). In our study, necropsy and evaluation of the macroscopic lesions allowed the diagnosis of CVCT, as the pathogenesis of this condition leads to a specific onset of lesions, as observed in our findings.

CONCLUSION

This study concluded that CVCT is one of the main causes of death in bovines from Santa Catarina state, mainly in adult dairy cows, requiring attention from veterinarians for the correct diagnosis. This disease is characterized by a variety of pathological changes, leading to different clinical signs and progression of the clinical course. The main clinical course was chronic. Hemoptysis, anorexia or hyporexia, and respiratory

distress were the clinical signs frequently seen, but not in every single case. Pulmonary hemorrhage, hepatic abscesses, septic thrombophlebitis of the caudal vena cava, and embolic pneumonia were the main lesions observed and, therefore, characterized the condition. Furthermore, the necropsy examination, associated with the clinical history and clinical signs, was crucial to diagnosing CVCT.

ACKNOWLEDGMENTS

This work was supported by the Instituto Federal Catarinense (IFC), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), project nº 422935/2016-6, and partially by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Brasil — Finance code 001. Authors are also grateful to Dr. John F. Edwards, Professor Emeritus at Texas A&M University for reviewing the manuscript.

DECLARATION OF CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship or publication of this article.

AUTHORS' CONTRIBUTIONS

FFP was responsible for data collection and interpretation, as well as drafting the manuscript, under supervision of REM, TMAG, and DD. REM, FFP, MMP, AHG, LCH, VWH, TRM, AFB, and MEG conducted the necropsies. KRAB processed the materials from the necropsies. All authors critically revised the manuscript and approved the final version.

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