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Intra-abdominal hypertension secondary to chronic diaphragmatic rupture in a dog

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ABSTRACT: *Intra-abdominal hypertension (IAH) is the persistent increase of intra-abdominal pressure (IAP) that could be caused by several pathologies. It is capable of promoting organ dysfunction, thereby increasing the mortality rate of human patients. As for cats and dogs, there are still few reports on how this pressure can be monitored and treated as a routine for admitted and hospitalized animals and on its relationship with the mortality of the patients. Therefore, the objective of this paper was to report a case of IAH secondary to chronic diaphragmatic rupture in a dog, which was treated with a temporary abdominal closure (TAC). A bitch was admitted to the veterinary hospital to undergo an elective ovariohysterectomy when it was diagnosed with a diaphragmatic rupture and displacement of the liver and intestinal loops in the chest. After repositioning these structures in the abdominal cavity, tension was observed in the abdomen. A temporary abdominal closure was then performed with a Bogota bag. Immediately after the surgery, the IAP was measured, presenting a value of 15 mmHg, indicating that there was an increase in intra-abdominal pressure. The animal was hospitalized, and IAP was monitored. After 24 hours, IAP was 5.8 mmHg when the Bogota bag was removed, and definitive celiorraphy was performed. The patient showed satisfactory clinical progress and was discharged 72 hours after the surgical procedure. The treatment used for IAH proved to be effective and contributed to the quick and satisfactory recovery of the patient.*
Key words: *intra-abdominal pressure, abdominal compartment syndrome, Bogota bag.*

Hipertensão intra-abdominal secundária à ruptura diafragmática crônica em um cão

RESUMO: *A hipertensão intra-abdominal (HIA) é o aumento persistente da pressão intra-abdominal (PIA), podendo ser causada por diversas afecções e caraterizada por promover disfunções orgânicas, aumentando a taxa de mortalidade no homem. Em cães e gatos, ainda há poucos relatos da monitoração dessa pressão e do seu tratamento na rotina dos animais admitidos e internados, e sua relação com a mortalidade dos pacientes. Assim, objetivou-se relatar um caso de HIA secundária à ruptura diafragmática crônica em cão, a qual foi tratada com o fechamento abdominal temporário (FAT). Uma cadela foi admitida no hospital veterinário para realização de uma cirurgia de ovário-histerectomia eletiva, quando foi diagnosticada com ruptura diafragmática com fígado e alças intestinais deslocadas para o interior do tórax. Após reposicionamento dessas estruturas na cavidade abdominal, observou-se tensão no abdômen. Realizou-se então o fechamento abdominal temporário com bolsa de Bogotá. Imediatamente após o término da cirurgia, a PIA foi aferida e seu valor era de 15 mmHg, indicando aumento da mesma. O animal foi mantido internado e sua PIA monitorada. Após 24 horas seu valor era de 5,8 mmHg, quando a bolsa de Bogotá foi removida e realizada a celiorrafia definitiva. O paciente teve evolução clínica satisfatória e 72h após a cirurgia recebeu alta hospitalar. O tratamento utilizado para a HIA se mostrou eficaz, contribuindo para a rápida e satisfatória recuperação da paciente.*
Palavras-chave: *pressão intra-abdominal, síndrome compartimental abdominal, bolsa de Bogotá.*

Intra-abdominal pressure (IAP) is the pressure inside the abdominal cavity. It is determined by body mass index, posture, abdominal wall muscle activity, breathing, and the size of the intra-abdominal organs. Therefore, a change in any of these components will result in an increase in the IAP (VILANI et al., 2016). A persistent increase in the IAP and the consequent intra-abdominal hypertension (IAH) contribute to organ dysfunction and can lead to abdominal compartment syndrome (ACS) (VILANI et al., 2016). According to ANDRADE (1998), the factors that increase the IAP in human patients may be acute or chronic conditions like intra-abdominal abscesses, peritonitis, acute gastric dilation, and repair of large abdominal and diaphragmatic hernias, among others. IAH and ACS restrict flow in the

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inferior vena cava and reduce venous return and cardiac output, resulting in hypoperfusion and/or systemic hypotension. Moreover, the increase in IAP can promote a decrease in abdominal perfusion pressure (MALBRAIN et al., 2006), which leads to the deterioration of visceral circulation, as maintained by ELATROUSH et al. (2015). Thus, it is possible to observe the direct and indirect damage to the organs (GONÇALVES et al., 2011), which in turn promotes kidney (JANG et al., 2019), gastrointestinal, and respiratory diseases (JANG et al., 2018). Diagnosis of IAP is based on the indirect urethral catheterization technique. As reported by COELHO (2019), the potential physiological values for dogs range from 0 to 7.5 mmHg, with a mean value of 3.09 ± 2.2 mmHg, where 1 mmHg is equivalent to 1.36 cm H_2O (GONÇALVES et al., 2011). Accordingly, the objective of this paper was to report a case of IAH secondary to chronic diaphragmatic rupture in a dog that was managed with a temporary abdominal closure.

A two-year-old mixed-breed bitch weighing 10 kg was admitted to the veterinary hospital for an elective ovariohysterectomy as part of a spay and neuter campaign. During the clinical and laboratory examination, the parameters were observed to be within the normal ranges for the species. The animal was then referred for ovariohysterectomy. When anesthesia was administered and at the beginning of the surgical procedure, the animal presented with dyspnea, which resulted in complications with ventilation. Suspecting there was a diaphragmatic rupture, the diaphragm was inspected, and the suspicion was confirmed. The animal had a partial right-sided diaphragmatic rupture, which appeared to be chronic, and displacement of the liver and intestinal loops in the chest cavity. After inspecting the viscera, which proved to be macroscopically viable, the liver and intestinal loops were repositioned in the abdominal cavity. After repositioning these viscera in the abdominal cavity, a condition of hypotension was observed, and the systolic blood pressure (SBP) (measured by oscillometry and Doppler) was found to be approximately 75 mmHg. At that moment, a load test was performed with Ringer's Lactate solution (20 mL/Kg in 15 minutes), followed by the use of 7.5% hypertonic saline solution (4.0 mL/Kg in 10 minutes) to restore blood pressure. Since blood pressure was not restored, a continuous administration of norepinephrine (0.2 mcg/kg/minute) was introduced after 40 minutes of the load test. After repositioning the viscera in the cavity, debridement of the edges of the diaphragm was performed as they were slightly thick. Next, the diaphragm muscle was sutured with 2-0 monofilament nylon in a Sultan suture pattern. The increased volume of the liver, in addition to the swelling of the intestinal loops from handling, made it impossible to definitively close the abdomen. The solution was to perform a temporary abdominal closure (TAC) with the use of a Bogota bag to accommodate the viscera and prevent IAH and ACS. Based on a study by FELICIANO & GAONA (2018), the Bogota bag was made with polyvinyl chloride (PVC) material using a 500 mL bag of sterile 0.9% sodium chloride solution and was molded into an elliptical shape large enough for the viscera to remain in the abdominal cavity without apparent pressure (Figure 1). At the end of the surgical procedure, systolic blood pressure was within the normal range for the species, which was 100 mmHg.

After the Bogota bag was fixed, a sterile non-compression abdominal bandage was applied. The bandages were changed aseptically once a day in the operating room. Cephalothin (30 mg/kg/IV) TID, meloxicam (0.1 mg/kg/IV) SID, tramadol hydrochloride (5.0 mg/kg/SC) TID, metronidazole (15 mg/kg/IV) BID, and dipyrone (25 mg/kg/IM) TID were prescribed for the postoperative phase, and the patient was referred to the intensive care unit. The patient's condition was monitored by assessing clinical parameters, checking blood pressure using the oscillometric method, and measuring IAP by the indirect method described by COELHO (2019), with an interval of 12 hours during a period of 24 hours. To measure the IAP, urethral catheterization was performed with a number 08 PVC urethral catheter lubricated with 2% lidocaine gel. After urethral catheterization, the animal was placed in the supine position, and a three-way stopcock was attached to the catheter in order to completely drain the urinary bladder. An amount of sterile 0.9% sodium chloride solution diluted in 1.0 mL/kg was then infused into the urinary bladder (WAY & MONNET, 2014). Subsequently, the three-way stopcock was attached to the circuit containing a 150 cm water column, which was affixed to a ruler marked in cm. The urethral catheter and the three-way stopcock were positioned at the level of the pubic symphysis so that the zero (0) of the water column/ruler was at this level. Readings of the IAP began when the three-way stopcock was open for the urethral tube and water column to reach equilibrium. This equilibrium was measured with the aforementioned ruler and recorded in accordance with COELHO (2019). IAP was 15 mmHg (20.4 cmH_2O) right after the surgery, 6.0 mmHg (8.16 cmH_2O) after 12 hours, and 5.8 mmHg (7.8 cmH2O) at the

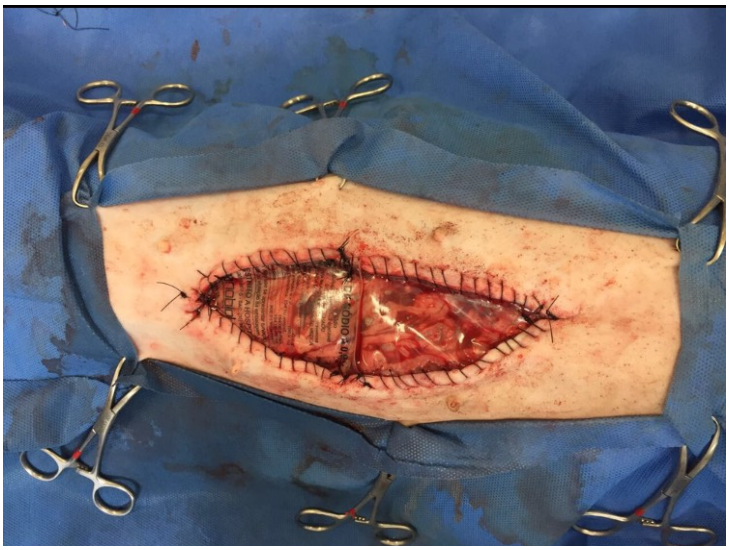

Figure 1 - Bogota bag used in a dog's abdomen. A polyvinyl chloride bag made from a 500 mL bag of sterile 0.9% sodium chloride solution, molded into an elliptical shape, and affixed to the abdominal wall with a simple continuous suture pattern, as a device for temporary abdominal closure.

end of 24 hours. At these intervals, mean arterial pressure (MAP) and systolic pressure (SBP) were also measured, showing the respective values of 96 mmHg and 130 mmHg 12 hours after the operation and 85 mmHg and 115 mmHg 24 hours after the procedure. Therefore, after 24 hours, the patient's vital parameters and IAP were within the normal range for the species. As a result, the patient underwent a new procedure to remove the Bogota bag, followed by the definitive celiorraphy. With its satisfactory clinical progress, the patient was discharged three days after the first surgical procedure.

In this report, the patient presented with macroscopic changes in the liver, which was visually enlarged and congested. Based on GONÇALVES et al. (2011), a slight increase in the volume of the organs, as found in the liver of this animal, may produce large elevations in IAP. Consequently, repositioning the enlarged liver in the abdominal cavity of this animal probably promoted a sudden increase in IAP, which may have compressed the inferior vena cava and reduced venous return, leading to systemic hypotension, as observed in the transurgical procedure performed on the animal in this report. To prevent this sudden increase in IAP and its systemic consequences in these cases, a careful evaluation by clinicians, surgeons, anesthetists, and veterinary criticalists is essential before promoting abdominal closure (GONÇALVES et al., 2011; VILANI et al., 2016).

Based on FELICIANO & GAONA (2018), TAC was the selected procedure in this report, as primary closure of the abdominal wall was not possible due to the pressure on the intra-abdominal tissues, where abdominal tension was observed macroscopically upon approaching the abdominal muscles. RODRIGUES JUNIOR et al. (2015) maintain that the methods for TAC should promote containment of the abdominal viscera, limit contamination, inhibit adhesions and damage to the abdominal wall, and prevent ACS in humans. In this case, the Bogota bag, as recommended by FELICIANO & GAONA (2018), was selected for the temporary closure. According to DRUMOND et al. (2016), this device allows for a review of the cavity (if necessary) and protects the edges of the surgical incision; namely, it provides for the comfortable accommodation and proper perfusion of the viscera. The Bogota bag in this report met the characteristics of a device for temporary closure, as it allowed for the accommodation of viscera without causing any injuries. It also prevented the consequences of IAH

since immediately after surgery, the IAP was 15 mmHg (20.4 cmH2O), a value considered high for the canine species. However, after placing the Bogota bag, there was a decrease in IAP in the postoperative period, which was 5.8 mmHg (7.8 cmH2O) after 24 hours, a value thought to be within the normal range for the species. This decrease was probably a consequence of the reduction in hepatic congestion since the liver was repositioned in the cavity, thereby decreasing the possibilities for venous obstruction in this organ, which is common when it moves to the chest cavity. Furthermore, an abdominal perfusion pressure (APP) of 79.2 mmHg was observed 24 hours after the procedure, which is within the normal range according to MALBRAIN et al. (2006), as it should be above 60 mmHg. APP is the difference between the MAP and the IAP (MALBRAIN et al., 2006); thus, when the IAP increases, there is a decrease in the APP (MALBRAIN et al., 2006), which can lead to the deterioration of visceral circulation and liver function (ELATROUSH et al., 2015). According to RODRIGUES JUNIOR et al. (2015), the decrease in IAP and the patient's clinical progress should be taken into account when definitive abdominal closure is to be performed on human patients. In this report, a definitive closure was performed 24 hours after TAC, as the animal met the clinical parameters and its APP and IAP were within the reference range for the species. In conclusion, the use of the Bogota bag on this animal was an effective solution for intra-abdominal hypertension, as it contributed to the patient's rapid and satisfactory recovery.

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ETHICS AND BIOSECURITY COMMITTEE STATEMENT

We, the authors of the article entitled "Intra-abdominal hypertension secondary to chronic diaphragmatic rupture in a dog," for all intents and purposes, declare that the project that gave rise to its data was not submitted to the Ethics Committee of the Federal University of Minas Gerais for evaluation. However, we are aware of the provisions of the resolutions of the Conselho Nacional de Controle de Experimentação Animal - CONCEA (http://www.mct.gov.br/index.php/content/view/310553.html) for projects involving animals.

Therefore, the authors assume full responsibility for the data presented herein and are available to answer any questions should they be required to by the competent authorities.

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

The authors contributed equally to the manuscript.

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