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CASE REPORT
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Canine Fetus with Presumed Encephalitis and Hydrocephalus: Qualiquantitative Ultrasonographic Evaluation of the Central Nervous System

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ABSTRACT

***Background*:** Cerebral echobiometry involves the ultrasound evaluation of the brain by analyzing the appearance of cerebrospinal fluid and cranial structures, and measuring them, aiding in the investigation and monitoring of central nervous system disorders. Brain mass and volume indices (BMI and BVI) can be measured during the intrauterine period, providing valuable information for the early and accurate diagnosis of disorders such as ventriculomegaly. The study aimed to describe a case of presumed hydrocephalus and meningoencephalitis in a 5-week-old canine fetus, and to report the role of a quali-quantitative ultrasonographic approach to the detection and monitoring of this condition.

***Case*:** A 1-year-and-9-month-old bitch Pinscher, weighing 1.59 kg, with a 31-day history of mating, was brought to the veterinary hospital with a dark, bloody vulvar discharge for one day. Ultrasound evaluation revealed the right uterine horn filled with anechogenic fluid and suspended echogenic spots, along with a viable fetus with a mean heart rate of 211 bpm, surrounded by an echogenic and irregular placenta. Gestational age was estimated at approximately 30 days, based on organogenesis. Subsequent ultrasonographic exams detected the fetus with an enlarged cranial vault and lateral ventricles distended with a hypoechoic content and suspended echogenic particles. Both BMI and BVI were lower than reference values (0.09 e 0.016, respectively), due to the increased area of the cranium (1.13 cm^2) and its volume (0.863 cm^3) and reduced brain mass area (0.05 cm^2 each hemisphere) and volume (0.006 cm^3 and 0.008 cm^3). The brain mass was irregular, hyperechoic, and retracted. On day 7 after presentation, the animal underwent an uneventful ovariohysterectomy. The right uterine horn revealed the amniotic sac containing an underdeveloped fetus with an enlarged, bulging skull. Fetus was exteriorized and euthanized due to the previous reported alterations, incompatible with life.

***Discussion*:** The presumptive diagnosis of hydrocephalus was based on the progressive ventricular dilation and decreased brain mass (atrophy). These changes influenced the decrease in brain mass and volume indices observed in this study. The BMI and BVI values were below normal, indicating underdevelopment of the fetal brain relative to cranial growth, and corroborating qualitative ultrasound findings of hyperechoic brain mass with an irregular appearance and ventricular dilation. Hyperechoic spots within the anechogenic cerebrospinal fluid (suggesting cellular debris) associated with cortical shrinkage (atrophy) and increased echogenicity of the brain parenchyma may suggest brain inflammation in dogs. However, the definitive diagnosis of meningoencephalitis typically relies on serological testing and cerebrospinal fluid analysis, with histopathological analysis (considered the gold standard). This case report highlighted the importance of qualitative and quantitative intrauterine ultrasound in the early diagnosis and monitoring of central nervous system abnormalities in the referred fetus. Brain echobiometry, through the assessment of brain mass and volume indices, provided an objective measure of cerebral development and the progression of structural alterations. Despite the lack of histopathological or serological confirmation, the detection of alteration in the echogenicity of the cerebral fluid pointed to an extra concern (meningoencephalitis) to be addressed along with the hydrocephalus. Therefore, this ultrasonographic approach can inform obstetric management by predicting the risk of dystocia, guiding the timing of surgical intervention during delivery, and supporting targeted postpartum care, ultimately contributing to a reduction in neonatal losses.

Keywords: dog, brain mass index, brain volume index, ventriculomegaly, ultrasonography.

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INTRODUCTION

Intrauterine brain ultrasound assessment encompasses a qualitative and quantitative approach as it investigates morphological characteristics such as echogenicity and echotexture of brain structures and the appearance of cerebrospinal fluid, in addition to enabling the monitoring of brain development through measurements of its area and volume [6].

The brain mass index (BMI) and brain volume index (BVI) have been described for healthy dogs as 0.19 and 0.04, respectively. The BMI was defined as the ratio of brain mass area (BMA) to area of the cranium (AC), whereas the BVI corresponded to the ratio of brain mass volume (BMV) to volume of the cranium (VC). Both indices remained constant across breeds, body sizes, and gestational ages, thereby providing reliable indicators of normal brain development and facilitating the detection and monitoring of underdevelopment [6].

Brain echobiometry measurements, BMI and BVI, have been described for canine fetuses from the 5th to 8th week of gestation. Beyond the 8th week, however, the evaluation was hampered by the mineralization of the skull, which impeded adequate ultrasound evaluation [6].

The objective of this study was to describe the qualitative and quantitative ultrasound findings of the cranium of a 5-week-old canine fetus with ventriculomegaly. Furthermore, it demonstrated the importance of biometric investigation for the diagnosis and monitoring of central nervous system alterations in this canine fetus.

CASE

A 1-year-and-9-month-old bitch Pinscher, weighing 1.59 kg, with a 31-day history of mating, was brought to the veterinary hospital with a dark, bloody vulvar discharge for 1 day. Despite this finding, the animal maintained normal behavior and appetite, and physical examination, including vital parameters, revealed no abnormalities. Abdominal ultrasound was subsequently performed using a MyLab™X8VET system[1] with a multifrequency microconvex transducer (8-11 MHz) after clipping the abdominal hair and applying acoustic gel. During this exam, the animal was restrained and positioned in dorsal recumbency on a padded surface.

Ultrasound evaluation on day 0 revealed a thickened, hyperechoic, and irregular uterine wall and dense hypoechoic fluid within the left uterine horn (Figure 1). No fetus was identified in this region. An echogenic and amorphous intraluminal structure and reduced chorionic diameter were also noted when compared with the contralateral uterine horn. The right uterine horn presented anechogenic fluid with suspended echogenic spots, along with a viable fetus with a mean heart rate of 211 bpm, surrounded by an echogenic and irregular placenta. Gestational age was estimated at approximately 30 days, based on organogenesis, with thoracic and abdominal regions and cardiac chambers already distinguishable.

Blood count, renal and hepatic profiles, and urinalysis were within normal limits, except for monocytosis and increased alkaline phosphatase. The surgical team performed a physical examination and recommended ovariohysterectomy. Given the owner's refusal, follow-up was conducted through ultrasound monitoring, physical examinations, and periodic laboratory testing.

A new ultrasound exam was performed the following day (day 1), for fetal monitoring. This evaluation detected enlargement of the skull and dense, hypoechoic intracranial fluid with suspended echogenic dots, indicating fetal underdevelopment and malformation. The cerebral lateral ventricles were distended (ventriculomegaly) due to hypoechoic fluid.

On day 6, follow-up ultrasound for cerebral echobiometry demonstrated pronounced cranial vault bulging, further dilation of the cerebral ventricles, a hyperechoic brain mass with irregular, retracted surfaces bilaterally, and more evident placental abnormalities, including hyperechogenicity and irregularity (Figure 1).

Measurements of the cranium and brain were obtained as follows: area of the cranium (AC=1.13cm^2) and brain mass area (BMA=0.10cm^2; 0.05cm^2 each hemisphere) [Figure 1], brain mass index (BMI=0.09), volume of the cranium (VC=0.863cm^3), brain mass volume (BMV=0.014cm^3; 0.006cm^3 and 0.008cm^3 the hemispheres) and brain volume index (BVI=0.016), according to the methodology of Feliciano and colleagues [6].

On day 7, the animal underwent an uneventful ovariohysterectomy. The right uterine horn revealed the amniotic sac containing an underdeveloped fetus with an enlarged, bulging skull.

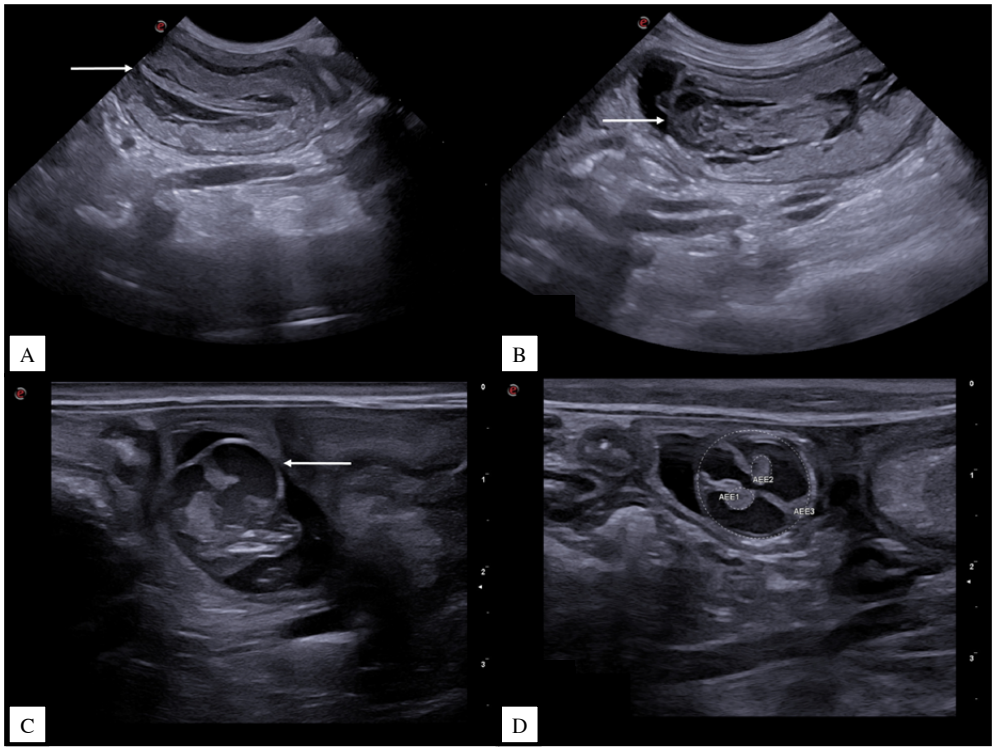

Figure 1. Abdominal ultrasound evaluation in B-mode showing a thickened, irregular uterus with heterogeneous echogenic content in the left uterine horn (A & B), suggestive of embryonic absorption; right uterine horn with an altered but still viable fetus (C & D). Bulging skull conformation, thinning of the cortical bone in the skull and increased intracranial volume, with a hypoechoic appearance and interspersed echogenic material are also noted in (C). Echobiometry of the fetal cranium in transventricular section with measurement of the brain mass area [area of the cerebral hemispheres = AEE1 and AEE2 = 0.05 cm^2 each] and area of the cranium [AEE3 = 1.13 cm^2] can be assessed in (D).

After the amniotic sac was opened, the fetus was exteriorized, and euthanasia was subsequently performed. Amniotic fluid (before opening the amniotic sac) and approximately 0.4 mL of intracerebral fluid (with a bloody appearance) were collected. Both fluid samples were sent for histopathological analysis, but these did not yield conclusive results for investigating the cause of fetal underdevelopment. Potential deficiencies during sample collection or improper handling and stogare of the material precluded cytological, histopathological, and serological analyses.

DISCUSSION

This report described the prenatal diagnosis of hydrocephalus and possible encephalitis in a 5-week-old canine fetus. At this gestational age, differentiation between thorax and abdomen, axial skeleton development, cardiac septation and chambers, and echogenic distinctions between liver and lung were detectable, consistent with previous reports [9].

The fetus evaluated in the present study exhibited an enlarged, bulging skull, in agreement with literature descriptions [4]. These characteristics could be visualized ultrasonographically and were confirmed during cesarean delivery, after exteriorization of the conceptus.

Clinical signs of hydrocephalus in dogs are variable, ranging from asymptomatic presentation to progressive neurological dysfunction [10]. However, neurological changes could not be investigated since the fetus was euthanized immediately after the cesarean section, due to prematurity and incompatibility with extrauterine life.

A presumptive diagnosis of hydrocephalus was made based on progressive ventricular dilation and decreased brain mass (atrophy), typical findings in dogs with hydrocephalus [2]. These changes influenced the decrease in brain mass and volume indices observed in this study, as previously reported in the literature [6].

The BMI and BVI values were below normal [6], indicating underdevelopment of the fetal brain relative to cranial growth, and corroborating qualitative ultrasound findings of hyperechoic brain mass with an irregular appearance and ventricular dilation.

Hyperechoic spots within the anechogenic cerebrospinal fluid (suggesting cellular debris) associated with cortical shrinkage (atrophy) and increased echogenicity of the brain parenchyma may suggest brain inflammation in dogs, as described in a canine transcranial ultrasonography report [3]. Although histopathological confirmation was not possible, we hypothesize that the presence of suspended hyperechoic spots visualized in the cerebrospinal fluid by ultrasound examination may be justified by the possible presence of mononuclear cells and protein, as reported by other authors who performed cytological analysis of the cerebrospinal fluid [5]. Therefore, a presumptive diagnosis of meningoencephalitis of possible inflammatory etiology was suggested, as previously reported [5].

Definitive diagnosis of meningoencephalitis typically relies on imaging studies, serological testing for infectious diseases such as *Neospora caninum*, canine distemper virus, and *Toxoplasma gondii* [8], and cerebrospinal fluid analysis [5], with histopathological analysis considered the gold standard [1]. Although serological tests were not performed, an infectious process associated with the inflammation of the cerebral ventricles can not be excluded. It is noteworthy that both inflammatory and infectious conditions can cause hydrocephalus [12].

The appearance of the left uterine horn, with a hyperechoic, thickened, and irregular wall with amorphous and echogenic intraluminal content, is suggestive of embryonic absorption [7]. Monocytosis and increased alkaline phosphatase associated with vaginal discharge and the ultrasonographic uterine changes (thickened and irregular wall and dense hypoechoic intraluminal content) may indicate an inflammatory-infectious condition, suggesting the possibility of metritis or pyometra, as described in the literature [11].

This case report highlighted the importance of qualitative and quantitative intrauterine ultrasound in the early diagnosis and monitoring of the central nervous system abnormalities, described in the reported fetus. Brain echobiometry, through the assessment of brain mass and volume indices, provided an objective measure of cerebral development and the progression of structural alterations. Despite the lack of histopathological or serological confirmation, the detection of alteration in the echogenicity of the cerebral fluid pointed to an extra concern (meningoencephalitis) to be addressed along with the hydrocephalus. Therefore, such evaluation can inform obstetric management by predicting the risk of dystocia, guiding the timing of surgical intervention during delivery, and supporting targeted postpartum care, ultimately contributing to a reduction in neonatal losses.

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Declaration of interest. Authors declare no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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