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Congenital hydrocephalus in a Maine Coon foetus detected using ultrasound during pregnancy

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Abstract: A congenital defect that blocks the cerebrospinal fluid outflow is the most common cause of hydrocephalus in young cats. It usually manifests itself within a few weeks of birth. Diagnostic imaging is essential. Therefore, it was decided to report on, for the first time, a clinical case of congenital hydrocephalus in a Maine Coon foetus detected using ultrasound during pregnancy. A difference between the size of the skull bones in the Maine Coon foetuses was recognised during a routine pregnancy ultrasound. Analysis of the sonogram of the bones and brain structures of the diagnosed foetus revealed that the features were highly suggestive of a hydrocephalus. Five clinically healthy kittens and one with hydrocephalus were delivered without complications. The necropsy of the malformed foetus was consistent with the ultrasonographic findings. Bacteriological and virological tests were performed and all were negative which suggest a congenital background of the malformation. This is the first reported case of an intrauterine ultrasound diagnosis of congenital hydrocephalus in a Maine Coon of multiple gestation. The ultrasound control along with the foetometry seem to be useful tools to recognise certain pathologies of pregnancy in cats, including congenital malformations of various origins, which is of significant diagnostic and prognostic importance.

Keywords: cat; foetal malformation; foetometry; gestation; ultrasonography

List of abbreviations

BP = biparietal diameter; **CSF** = cerebrospinal fluid; **CT** = computed tomography; **EEG** = electroencephalogram; **FeLV** = feline leukaemia virus; **FIP** = feline infectious peritonitis; **FIV** = feline immunodeficiency virus; **FPV** = feline panleukopaenia virus; **MRI** = magnetic resonance imaging; **US** = ultrasound

Hydrocephalus is a rarely documented feline neurological disease characterised by an abnormal dilation or expansion of the ventricular system due to an increased volume of cerebrospinal fluid (CSF) (Thomas 2010; Assis et al. 2012; Estey 2016). Hydrocephalus aetiologies in dogs and cats may impair the flow of CFS (Farke et al. 2020). A congenital defect that blocks the CSF outflow is the most common cause of hydrocephalus in young cats (Thomas 2010). Also, it can be caused by certain viruses, i.e., feline leukaemia virus (FeLV), feline panleukopaenia virus (FPV), feline immunodeficiency vi-

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rus (FIV), feline infectious peritonitis (FIP), as well as parasitic, bacterial and fungal infections or cysts, and tumours (Thomas 2010; Estey 2016). In cats, the postpartum diagnosis of nervous system defects associated with FPV has been reported by Greene et al. (1982) and Sharp et al. (1999). Hydrocephalus can result in clinical signs due to the loss of neurons or neuronal function, alterations in intracranial pressure and the associated pathophysiological effects of intracranial disease. The most common ones are dullness, neurological signs and seizures (Thomas 2010; Estey 2016).

Congenital hydrocephalus usually manifests itself within a few weeks of birth, and up to the age of one year, an abnormal dome shaped cranium can be observed, the bony orbits can be enlarged and the eyeballs can exhibit a ventrolateral strabismus (Thomas 2010; Assis et al. 2012; Estey 2016; Gradner et al. 2019). The acute onset of signs can occur with previously undiagnosed congenital hydrocephalus. Diagnostic imaging is essential. Skull radiographs, computed tomography (CT) and magnetic resonance imaging (MRI) are best for the visualisation (Thomas 2010; Gradner et al. 2019). A spinal tap and an electroencephalogram (EEG) are other diagnostic tests that can assist in the diagnosis of hydrocephalus. Moreover, in the brain, the intracranial anechoic contents can be identified using an ultrasound (US) (Assis et al. 2012).

The prognosis in this developmental abnormality is guarded to poor and the only medical treatment, in such cats, is the surgical reduction of the intracranial pressure, mostly by different kinds of ventriculoperitoneal shunts (Gradner et al. 2019). The surgical procedure is difficult and many times has no satisfactory effect. The time course without surgical treatment, in many cases, is weeks to months. It has been observed that three cat breeds are more likely to develop hydrocephalus: Siamese, Persian and Manx (Thomas 2010; Assis et al. 2012; Estey 2016). There is lack of information about the Maine Coon and usage of ultrasonography in the intrauterine control of this kind of foetal abnormality in the mentioned breed. Therefore, it was decided to report a clinical case of congenital hydrocephalus in a Maine Coon foetus detected using ultrasound during pregnancy.

Case presentation

During the routine ultrasound control of a Maine Coon pregnancy (2 year old queen, first pregnancy), the difference between the size of foetuses skull bones was recognised. An examination was conducted using a MyLab Gold Vet scanner with a microconvex probe 5.0 – 6.6 – 7.5 MHz (Turin, Italy). The average foetometric measurement of the biparietal diameter (BP) (Beccaglia et al. 2008; Socha and Janowski 2019) in five foetuses 26 days before delivery was 11.54 mm (Figure 1) and was 14.7 mm (Figure 2) in the pathologically enlarged one. This difference suggests an unknown background of a congenital abnormal head development in the examined foetus. Eight days afterwards, during the next US control, the skull

Figure 1. Sonogram of the biparietal diameter (BP) in a normal foetus 26 days before parturition

The crosses mark the distance between the biparietal bones. BP = 11.4 mm

Figure 2. Sonogram of the biparietal diameter (BP) in the hydrocephalus foetus 26 days before parturition

The crosses mark the distance between the biparietal bones. BP = 14.6 mm

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bones had grown and the difference increased to 20.6 mm and 29.94 mm (Figures 3 and 4). The analysis of the sonogram of the bones and brain structures of the diagnosed foetus revealed that the features were highly suggestive of hydrocephalus. After the next 7 days, five clinically healthy kittens and one with hydrocephalus were delivered without complications (Figure 5). A standard clinical examination of litter was performed to check the body weight, internal body temperature, heart rate, number of breaths, suckling reflex, mobility test, and, additionally, for the occurrence of external anatomical congenital abnormalities of the kittens. The parameters were as follows: the body weight ranged from 116 g to 154 g, the internal

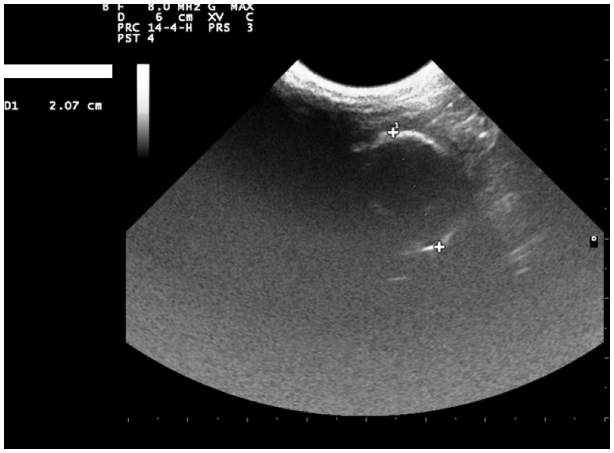

Figure 3. Sonogram of the biparietal diameter (BP) in a normal foetus 7 days before parturition
The crosses mark the distance between the biparietal bones. BP = 20.7 mm

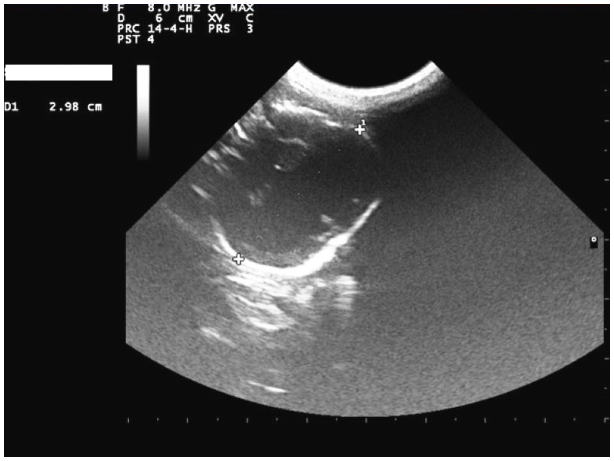

Figure 4. Sonogram of the biparietal diameter (BP) in the hydrocephalus foetus 7 days before parturition
The crosses mark the distance between the biparietal bones. BP = 29.8 mm

Figure 5. The hydrocephalus foetus after delivery

body temperature ranged from 36.1 °C to 37.2 °C, the heart rate ranged from 173 to 191 beats per minute, and the number of breaths was between 14 to 20 breaths per minute. All the healthy kittens were in good clinical condition. The suckling reflex was normal, the mobility test was positive, and in addition, no external anatomical congenital abnormalities were observed. The vital signs of the malformed kitten were normal, except for the suckling reflex which was absent and the mobility test which was negative. Moreover, a highly enlarged contour of the skull and open fontanel was observed. The ultrasound of the skull showed a large presence of free fluid in the ventricles of the brain. Therefore, after clinical examination and taking all of the discussed premises into account, the pet's owner decided upon euthanasia.

The necropsy of hydrocephalus foetus was consistent with the ultrasonographic findings. The post-mortem inspection revealed a massive dilatation of the ventricular cavities, filled with a clear cerebrospinal fluid and the subsequent compression of the adjacent brain parenchyma. These pathological changes were compatible with internal hydrocephalus.

Bacteriological and virological tests were performed on the material collected from the body of the hydrocephalus foetus (kidneys, lungs, liver, fluid from the body cavity), the foetal fluid and the mother's blood. The FeLV, FPV, FIV, FIP and *Chlamydia abortus* were tested in the external laboratory. All the performed tests were negative. None of the infectious causes of hydrocephalus could be found as the reason of the anatomical defect in the described case. The obtained results indicate a congenital background of the examined malformation. While there was no history of hy-

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drocephalus in this breed or in the related cats, a genetic cause cannot be ruled out.

All the conducted investigations were performed based on the clinical indications, according to the accepted ethical standards and broadly understood principles of good medical practice, and with the consent of the animal's owner.

DISCUSSION AND CONCLUSIONS

This is the first reported case of an intrauterine ultrasound diagnosis of congenital hydrocephalus in a Maine Coon with multiple gestation. There are no literature data describing this kind of specific foetal control during pregnancy in Maine Coon female cats before.

The conducted tests of the collected material and no evidence of infection, which highly suggested hydrocephalus, confirmed that, in the described case of a Maine Coon pregnancy with one foetus with hydrocephalus, the cause of a nervous system abnormality and the enlargement of the skull bones was a congenital defect. The evaluation of the ultrasound image of the foetal brain was consistent with that reported in the literature of neonatal hydrocephalus with an enlarged ventricular system filled with an anechoic content (Assis et al. 2012). Additionally the post-mortem examination results of the abnormal foetus were consistent with the data obtained by Thomas (2010), and indicated, i.e., ventriculomegaly and parenchymal atrophy. The obtained results verified the use of an ultrasound during pregnancy for the diagnosis and evaluation of foetal malformations in cats.

Furthermore, the changes seen in the sonograms of the examined head of the foetus, along with the enlargement of the skull bones in the abnormal foetus compared to the other healthy kittens, suggested a predisposition to dystocia and obstetric difficulties in delivery.

This allowed one to warn the owner of the upcoming delivery with a defective foetus and to present the possible application of appropriate perinatal procedures, which finally turned out to be unnecessary in this case.

To sum up, the results obtained in this report indicates the use of an ultrasound during pregnancy for the diagnosis and evaluation of foetal malformations in the Maine Coon. Additionally, the ultrasonographic foetometry method based on the measurement of the size of the examined structures and organs of the foetal body turned out to be necessary, not only in determining the date of delivery in physiological pregnancies (Beccaglia et al. 2008; Socha and Janowski 2019), but also in conducting physiological and pathological gestations, and in the prognosis of the condition of the foetuses. Therefore, it should be emphasised that an ultrasound control along with foetometry are useful tools for the recognition of certain pathologies of pregnant cats, including congenital malformations of various origins. This is not only of great diagnostic and prognostic importance for a veterinarian in charge of an atypical pregnancy as an additional tool to enable appropriate procedures at the right time, but it also significantly affects the reproductive performance of queens. It can be of great value for the pet owners, not only for breeding cats such as the Maine Coon, but also for non-purebred cats.

Conflict of interest

The authors declare no conflict of interest.

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