Twinkle artefact diagnostic role when having dogs and cats’ digestive system ultrasonography

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Abstract. The article is devoted to the description of the Doppler twinkle artefact recorded during transcutaneous ultrasound examination of dogs and cats’ alimentary canal and characterization of its clinical significance. The object of the study are dogs of different ages and different breeds (45) and cats (53). Ultrasound was performed on SonoAce R7 scanners (Samsung Medison Co., Ltd., Seoul, South Korea) and SIUI Apogee 1100 (Shantou Institute of Ultrasonic Instruments Co., Ltd., Guangdong, China) according to the standard technique using multifrequency convex and linear sensors with frequencies of 3.5-12 MHz. Reproduction of the twinkle artefact in the model was carried out using a plastic container with water in which objects with different densities and interfaces were placed. The characteristic of the “twinkle artefact” in Doppler scanning modes which we register only in pathology is given. In 14.7% of cases it was recorded on the surface of foreign bodies of the small intestine. When the artefact was reproduced in the model and it was established that it appeared on objects with a rough surface and high reflectivity. Also “twinkle artefact” is described with hepatic parenchyma focal area of mineralization.

1. Introduction

Image artefacts always accompany an ultrasound examination of the alimentary canal and associated organs. This is due to several reasons: the specialist’s ultrasound diagnostics experience, the patient characteristics and condition, equipment settings and characteristics, the physical laws governing the propagation of an ultrasound wave in biological tissues [1, 2, 3].

The International Dictionary of Medicine and Biology provides the following definition of an artefact: “any record or image obtained using medical diagnostic methods which is random and does not represent the structures under study” [4].

In-depth knowledge of the causes, elimination and interpretation of artefacts is a prerequisite for the correct clinical assessment of ultrasound images [1, 3].

In national and foreign literature issues related to the diagnostic value of ultrasound artefacts in veterinary gastroenterology of small pets are not sufficiently highlighted. Purpose of the study: to describe the Doppler twinkle artefact recorded during transcutaneous ultrasound examination of dogs and cats’ alimentary canal and to characterize its clinical significance.
2. Materials and methods
The object of the study was cats and dogs of both sexes of different ages and breeds. The studies were carried out at the Scientific-Diagnostic and Medical Veterinary Center of the FSBEI HE "Stavropol State Agrarian University" and the Pirogov Veterinary Center in Stavropol in the period from 2016 to 2019. The results of examination of 45 dogs and 53 cats were taken into account. Ultrasound was performed on SonoAce R7 scanners (Samsung Medison Co., Ltd., Seoul, South Korea) and SIUI Apogee 1100 Omni (Shantou Institute of Ultrasonic Instruments Co., Ltd., Guangdong, China) according to the standard technique using multifrequency convex and linear sensors with frequencies of 3.5-12 MHz. The animals were examined in dorsal, left and right side recumbency. The reproduction of the twinkle artefact in the model was carried out using a plastic container with water into which various objects were placed selected according to 4 criteria: objects with low reflective properties and a flat surface (silicone), objects with low reflective properties and a rough surface (porous foam rubber), objects with high reflectivity and smooth surfaces (glass and steel balls) and objects with high reflectivity and rough surfaces (fragments of solid rock). The study was carried out in two-dimensional gray-scale imaging (B-mode), color Doppler mapping (CDM), energy Doppler mapping (EDM), spectral mode and B-flow mode.

3. Results
When there are foreign bodies in small intestine cavern in a number of cases we recorded a special artefact in the Doppler scanning modes on their surface. Using CFM mode the artefact was visualized with a rapidly changing color spectrum in the form of mixing red and blue colors (figure 1).

![Figure 1. Twinkle artefact. Duplex scanning: gray-scale B-mode + color Doppler mapping (DCM). The twinkle artefact is represented by a vivid color scheme as a result of mixing red and blue colors on the surface of a foreign body. Left side: a fragment of a plastic toy in 18 months cats of Don Sphynx breed jejunum. Acoustic shadow is distal to the foreign body; on the right - a foreign body (coin) in the jejunum of an outbred 18 months old cat. The twinkle artefact originated from the fluted edge of the coin.](image-url)

When using EDC mode monochrome color coloration is determined. In the spectral Doppler mode a spectrum is recorded represented by high-amplitude low-frequency oscillations that do not have a waveform and is accompanied by a specific sound signal ("creak"). When using B-flow mode a twinkle white linear structure is artefact distinctive visualization.

We have identified this phenomenon as a "twinkle" artefact. The intensity of color staining varied from single unstable color signals to apparent stable surface staining. The spectral characteristics remained unchanged regardless of the severity of the Doppler artefact in the CDC and EDC modes.
Of the observed 34 clinical cases of foreign bodies presence in dogs and cats, small intestine a twinkle artefact was recorded only in the presence of an object with high reflective properties and a rough surface (5 clinical cases, including 4 cats).

The “twinkle” artefact normally needs to be differentiated from the motion artefact also seen in Doppler modes. It is caused by the alimentary canal motility as well as the movement of its contents. Using the CDC mode an extravascular mixed blue-red coloration of the moving intestinal walls and contents unrelated to the cardiac cycle is recorded (figure 2).

![Figure 2. Artefact of movement. Duplex scanning: (B-mode + CFM) + (B-mode). The artefact arose from jejunum peristalted loops of 6 months male pit bull terrier. An atypical mixed color Doppler staining of the intestinal walls at the time of movement is visualized.](image)

Liquid or gas movement artefact in the peristalized loop of the intestine is distinguished by instability and a rapid change in the nature of its manifestation associated with peristalsis while the effect consists of multiple separate color signals of a linear form.

When reproducing the “twinkle” artefact in the model using various objects placed in a container with water we registered this phenomenon in Doppler scanning modes only on objects with high reflectivity and a rough surface (figure 3).

![Figure 3. Reproduction of the twinkle artefact in the model. Duplex scanning. Left side: no artefact on the smooth surface of the glass sphere (B-mode) + (B-mode + CFM); on the right - the presence of an artefact on the rough surface of a fragment of solid rock (B-mode) + (B-mode + EDC). The surface of objects in B-mode is rendered as a hyperechoic line which indicates their highly reflective properties.](image)
In a number of cases we registered a “twinkle” artefact from hepatic parenchyma focal area of mineralization (figure 4, left part), however, the artefact manifestation depended on focal area size. The artefact was absent having focal area less than 3 mm (figure 4, right side).

Figure 4. Left side: twinkle artefact and acoustic shadow artefact from mineralization focal area in the liver of 8-year-old mongrel cat. Duplex scanning: (B-mode + CFM) + (B-mode); the right side - the absence of a twinkle artefact from small focal area of mineralization (1.5-2 mm) in the hepatic parenchyma of 16 months mongrel cat.

4. Discussion
It is known that when using Doppler scanning modes the contrast between blood flow and tissue is provided by the difference between a moving and stationary acoustic interface, color rendering of moving erythrocytes and the display of stationary reflectors in gray scale. In general, this results in soft tissue visualization as a gray shadow and blood vessels as a color. However, in the case of soft tissue movement their vibrations can be detected as artefact color mixed extravascular display.

A “twinkle” artefact of Doppler scanning modes when examining the alimentary canal and associated organs is registered only in pathology and can provide additional information about the object under study.

This artefact in humanitarian medicine was first recorded by Gooding G A et al (1991) when examining a patient with a metal clip applied to the carotid artery [5]. The term "twinkling artefact " (or twinkling sign) appeared in 1996 [6].

The "twinkle" artefact was first described by national authors in 1997 during transrectal ultrasound of humans prostate calcifications [7]. The physical basis of the phenomenon was studied in the experiment by S P Weinstein et al (2002), the authors attributed color coloration to the phenomenon of acoustic resonance [8].

For the first time in veterinary medicine the twinkle artefact was described, apparently, in 2006 for dogs and cats’ urolithiasis [9].

The description of the twinkle artefact when studying the digestive tract in literature is limited and is mainly devoted to calcifications of hepatic parenchyma and cholelithiasis. Olkhova E B (2007) recorded twinkle artefact in 27.8% of cases when coprolites of various sizes were detected in children [10]. However, the author took for twinkle artefact all cases of atypical Doppler staining in the study of dense objects, soft tissue structures or air flow and therefore probably took into account the Doppler motion artefact as a twinkle artefact.

We registered a "twinkle" artefact in 14.7% of cases with presence of foreign bodies in digestive canal cavern and did not register it in presence of coprolites. Our reproduction of the twinkle artefact in the model showed that it occurs on objects with a rough surface and high reflectivity. This phenomenon arises, in our opinion, due to the multidirectional reflection of the ultrasonic flow from multiple reflectors that create roughness on the object’s surface while the shift of the resulting flows when processing the signal from multiple reflectors leads to artefact formation.
During our studies we registered twinkle artefact from focal area of mineralization in the hepatic parenchyma, however, in presence of focal area less than 3 mm, the artefact was absent which can be explained by a small reflecting surface and a small difference in acoustic impedances at the interface.

5. Conclusions
Thus, the registration of a "twinkle" artefact using Doppler scanning modes on the surface of objects in the alimentary canal indicates their high reflectivity and rough surface and is found on some foreign bodies and focal area of mineralization.

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