Theriogenology 86 (2016) 1654–1661

Contents lists available at ScienceDirect

Theriogenology

journal homepage: www.theriojournal.com

Assessment of umbilical artery flow and fetal heart rate to predict delivery time in bitches

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ARTICLE INFO

Article history:
Received 1 December 2015
Received in revised form 30 March 2016
Accepted 31 March 2016

Keywords:
Dog
Fetal ultrasonography
Doppler ultrasonography
Resistive index
Heart rate

ABSTRACT

The aim of this study was to quantitatively investigate the oscillation of the fetal heart rate (HR) in advance of normal delivery and whether this index could be used to indicate impending delivery. In addition, fetal HR oscillation and umbilical artery resistive index (RI) were correlated to determine if the combination of these parameters provided a more accurate prediction of the time of delivery. Sonographic evaluation was performed in 11 pregnant bitches to evaluate the fetal HR and umbilical artery RI at the following antepartum times: 120 to 96 hours, 72 to 48 hours, 24 to 12 hours, and 12 to 1 hours. Statistical analysis indicated a correlation between the oscillation of fetal HR and the umbilical artery RI. As delivery approached a considerable reduction in the umbilical artery RI was documented and greater oscillations between maximum and minimum HRs occurred. We conclude that the quantitative analysis of fetal HR oscillations may be used to predict the time of delivery in bitches. The combination of fetal HR and umbilical artery RI together may provide more accurate predictions of time of delivery.

1. Introduction

After pregnancy diagnosis, a successful outcome requires that the neonates can survive in the extrauterine environment [1–3]. For veterinarians, owners, and breeders, the major concern when planning cesarean delivery is to maximize neonatal survival forwarding the bitch for surgery with mature fetuses [4]. Ability to predict an appropriate time of delivery to maximize viability, before the onset of intrauterine fetal distress, would improve neonatal survival.

Ultrasonography can be used to estimate gestational age in dogs. A variety of methods have been described involving morphologic evaluations, for example, crown-rump length at the beginning of pregnancy and biparietal diameter or the evaluation of fetal organogenesis by sequential examinations [5–9]. However, these ultrasonographic methods are not sufficiently accurate so as to predict the exact date of parturition and can result in premature preparation for normal delivery or planning for cesarean delivery [7,8].

In a recent publication, we introduced new sonographic parameters, which provide more accurate estimation of the expected delivery date in dogs. These parameters include fetal heart rate (HR) acceleration and deceleration during the antepartum period [10] and changes in umbilical artery blood flow, more specifically the resistive index (RI), at the end of canine pregnancy [11].

Our hypothesis is that a combination of fetal HR oscillations and umbilical artery RI could provide more accurate predictions of delivery date. Therefore, the purpose of this study was 4-fold: (1) to provide quantitative definition of the oscillations in fetal HR in bitches with normal delivery; (2) to identify percentage (relative to maximum) of fetal HR variation at different times close to the delivery time; (3) to document any correlation between the fetal HR oscillations

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0093-691X/$ – see front matter © 2016 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.theriogenology.2016.03.042

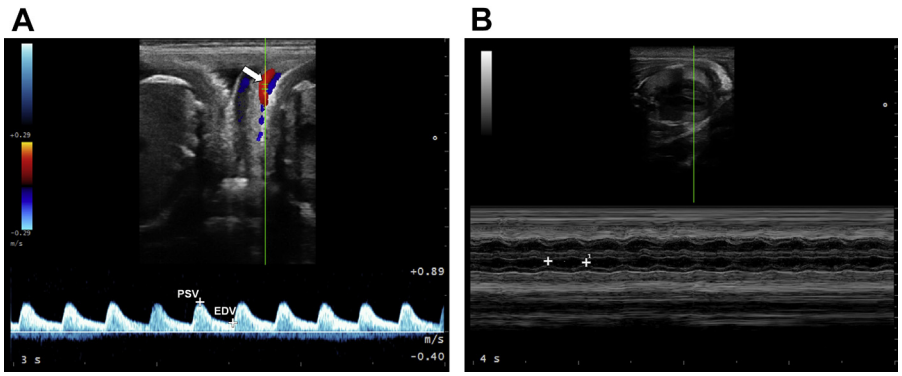

Fig. 1. Images of gestational ultrasonography in a bitch. (A) Evaluation of a fetal umbilical artery. The umbilical cord is visualized by color Doppler (arrow), umbilical artery is red and umbilical vein is blue. The pulsed-wave Doppler sample volume was placed in the center of the umbilical artery to obtain the waveforms. Peak systolic velocity (PSV), 0.42 m/s; end-diastolic velocity (EDV), 0.12 m/s; resistive index, 0.71. (B) Representative fetal heart M-mode ultrasonography to measure the heart rate. Heart rate, 166 bpm. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

and the RI of umbilical artery flow; and (4) to determine if the combination of fetal HR variation and the RI of umbilical artery flow would provide a more accurate prediction of delivery date than either parameter alone.

2. Materials and methods

2.1. Patient selection

The study was conducted on 11 clinically healthy pregnant bitches which went on to have a normal delivery. Several breeds were represented including Boxer (1), Chihuahua (1), English Cocker Spaniel (1), Maltese (1), Pekingese (1), Pinscher (1), Pit Bull Terrier (1), Miniature Schnauzer (1), Siberian Husky (1), X-breed (1), and Yorkshire Terrier (1). The bitches ranged from 1 to 4 years of age and delivered between 3 and 11 fetuses each. All procedures were conducted in accordance with the institutional Animal Use Committee guidelines. Inclusion criteria were bitches without concomitant disease and with a positive pregnancy diagnosis that were available for serial examinations.

2.2. Ultrasound imaging and techniques

Two-dimensional and Doppler ultrasonographic evaluations were carried out using a MyLab 30 machine (Esaote, Genova, Italy) with a 7.5 to 12 MHz linear multifrequency transducer (LA523 reference–Esaote, Genova, Italy). Abdominal hair was clipped to optimize the ultrasonographic image, the bitches were restrained in dorsal recumbency using a sponge trough, and acoustic gel was applied to the transducer. Image quality was maximized by adjusting the gain, focus, and depth penetration for each fetus during examination.

The bitches were followed by ultrasonographic examination from the 30th day after the first mating or insemination to pregnancy diagnosis. Ultrasonography examinations were performed every 4 days until the eighth week of gestation, and on each examination, fetal organogenesis and age were evaluated [12]. After the examination at the eighth week, assessments were performed daily until delivery to assess umbilical artery blood flow and fetal HR.

The examination protocol included scanning the whole abdomen by circling clockwise, starting with the fetus in the left uterine horn (cranial to caudal) followed by the right horn (caudal to cranial). Measurements were made in

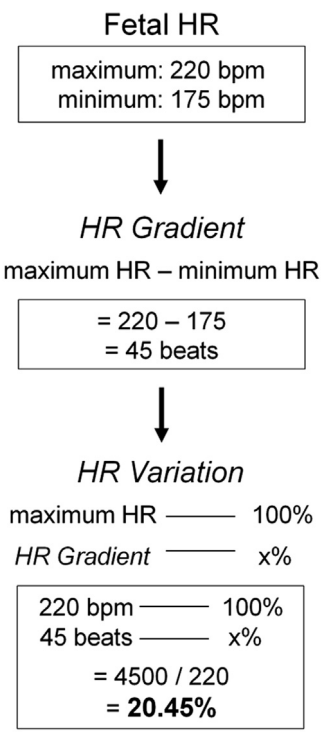

Fig. 2. Parameters for analysis of the oscillation of the fetal heart rate (*HR gradient* and *HR variation*) and mathematical method for such acquisitions. HR, heart rate.