Ultrasonographic Doppler Use for Female Reproduction Management

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KEYWORDS

• Doppler ultrasonography • Blood flow • Uterus • Ovary • Estrous cycle • Pregnancy • Puerperium • Cattle

KEY POINTS

- During all reproductive stages, characteristic changes in uterine blood flow are observed.
- Within the first 3 weeks after insemination, before visibility of the embryo by B-mode sonography, differences in uterine and luteal blood supply are detected in early pregnant compared with cyclic cows.
- Because there is a high variability in uterine and in luteal blood flow these parameters are not useful for an early pregnancy diagnosis after a single investigation.
- Cows with puerperal disturbances show a delayed decrease in uterine blood flow in the first few weeks after parturition compared with healthy cows.
- Measurement of follicular blood flow may be used to identify normally developing follicles and to predict superovulatory response, whereas determination of luteal blood is a more reliable method than B-mode sonography to distinguish between functional and nonfunctional corpora lutea.

INTRODUCTION

The advent of B-mode ultrasonography in bovine reproduction in the 1980s heralded tremendous advances in research and clinical practice because it allowed for the first time the noninvasive visualization of the internal reproductive organs. Although organ morphology can be evaluated using this technique, it cannot provide information about organ function, such as vascular perfusion. Circulation of the bovine genital tract was initially investigated experimentally using invasive procedures.[1–3] For the

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past 15 years color Doppler ultrasonography has been increasingly used for blood flow studies in bovine reproduction.[4,5] This has led to new information about physiologic and pathologic processes of the genital tract in female cattle.

PRINCIPLE OF DOPPLER ULTRASONOGRAPHY

Ultrasound waves reflected from moving structures, such as red blood cells, differ in their frequency compared with the emitted waves, resulting in a Doppler shift. This shift is positive; that is, the frequency of the reflected waves is higher than that of the emitted waves when the red blood cells move toward the transducer. When the blood cells move away from the transducer, the frequency of the reflected waves is lower than that of the emitted waves and the Doppler shift becomes negative.[6]

TECHNIQUE OF DOPPLER ULTRASONOGRAPHY

Evaluation of Blood Flow

If the spectral mode of Doppler machines is used frequency shifts are displayed in a two-dimensional graph as a function of time, and a so-called Doppler wave is created in the course of the examination of the arterial blood flow during cardiac cycles (**Fig. 1**). In ultrasound machines with color Doppler capacity, the Doppler shifts are color-coded on the screen (**Fig. 2**). Positive shifts (blood flow toward the transducer) are usually indicated in red and negative shifts (blood flow away from the transducer) in blue. Power mode is an advanced method of imaging blood flow. In contrast to conventional methods, which measure the blood flow velocity, this technique measures blood flow intensity (ie, the number of red blood cells moving through a vessel per time unit). The blood cells are seen as colored foci projected onto the B-mode image. Compared with the conventional color Doppler technique, this method is superior for imaging very low blood flow, such as follicular blood flow (FBF) (**Fig. 3**).

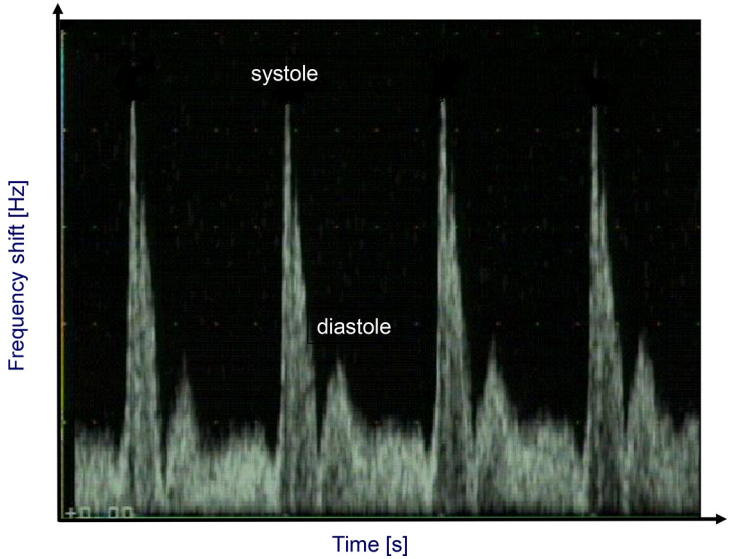

Fig. 1. Time-dependent changes in frequency shift of an artery during cardiac cycles detected by Doppler spectral mode.