

The effects of estrous cycle and pregnancy on echocardiographic variables in healthy bitches

Swanand R. Sathe, Jessica L. Ward

Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Iowa State University, Ames, IA

Pregnancy causes alterations in maternal hemodynamics, including increased stroke volume, cardiac output, and heart rate. Associated echocardiographic changes are well-described in women, but have been less consistently documented in bitches. Furthermore, it remains unknown whether the estrous cycle itself affects echocardiographic measurements in bitches, and whether hemodynamic changes in canine pregnancy vary with litter size. The objectives of this study were (1) to characterize changes in maternal echocardiographic variables throughout the reproductive cycle in bitches; and (2) to determine whether magnitude of changes in pregnancy are related to fetal number.

Nine healthy client-owned breeding bitches were enrolled prospectively and followed longitudinally throughout a single reproductive cycle. Physical examination, echocardiography (including left ventricular strain and 3-dimensional imaging), blood pressure, and plasma volume calculations were performed at 4 time points as determined by serum progesterone estimation and breeding dates: (1) proestrus (day 3-5 of bleeding), (2) early pregnancy (day 25-30 after breeding), (3) late pregnancy (day 45-60 after breeding), and (4) anestrus (30 days after weaning). Fetal echocardiography was also performed during late pregnancy visits. Data were compared across time points using paired t-tests.

Mean estimated plasma volume increased by 36% in early pregnancy ($p = 0.009$) and 62% in late pregnancy ($p = 0.0009$). No significant changes were observed at any time point in heart rate, blood pressure, echocardiographic measurements of left ventricular size or wall thickness, or echocardiographic calculations of stroke volume or cardiac output. Fetal echocardiography was feasible in a subset of fetuses for each bitch. There was a significant correlation between estimated total fetal cardiac output and maternal cardiac output in late pregnancy ($r = 0.86$). The incidence of physiologic heart murmurs ranged from 5/9 bitches in proestrus to 1/9 in late pregnancy, attributed to variations in aortic outflow velocity.

This study demonstrated that hemodynamic alterations in pregnant bitches do not result in consistently detectable echocardiographic changes, suggesting that cardiac screening could be diagnostic at any time during a bitch's reproductive cycle. Larger litters may be associated with higher maternal hemodynamic demand during pregnancy. Physiologic heart murmurs were common in this study population but were not obviously associated with reproductive cycle.

Keywords: Echocardiography, cardiac output, heart murmur, fetus, cardiac output