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USING COLOR DOPPLER ULTRASOUND TECHNOLOGY TO IMPROVE EMBRYO RECIPIENT SELECTION

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Embryo recipient selection is key to embryo transfer success

Embryo transfer provides seedstock producers a unique opportunity to increase the number of calves generated from genetically superior females. However, the success of an embryo transfer (ET) program depends heavily on selecting recipients capable of carrying a pregnancy to term. Factors like health, nutritional status, and fertility history are well known to influence pregnancy outcomes in embryo recipients. However, even when embryo recipients meet these criteria, approximately 10–30% are excluded from receiving embryos due to the absence of a functional corpus luteum (CL). Located within the ovaries, the CL is an endocrine gland that produces progesterone, a hormone essential for maintaining a suitable uterine environment for early embryonic development and pregnancy maintenance.

How do we know that an embryo recipient cow has a good corpus luteum?

Before transferring embryos, embryologists examine the reproductive tract of cows and evaluate their ovaries for the presence of a CL. This is accomplished using rectal palpation or transrectal ultrasonography. In addition to evaluating the presence of a CL, embryologists also evaluate the size and morphological characteristics of this structure to determine if the recipient is suitable to receive an embryo. This method is effective for selecting embryo recipients; however, recent studies suggest that color Doppler ultrasonography, which evaluates blood perfusion, can provide embryologists with a more thorough understanding of CL function, further optimizing embryo recipient selection.

Why is blood perfusion within the CL important?

The corpus luteum is a highly vascularized gland. Moreover, studies have shown that blood perfusion within the CL is a key indicator of its functionality and ability to produce progesterone. Color Doppler ultrasonography allows embryologists to identify variation in CL blood perfusion between cows. Hence, this technology enables a more comprehensive assessment of CL function in embryo recipients. Figure 1 shows representative ultrasound images collected from two embryo recipient cows that had similar CL size, but different blood perfusion.

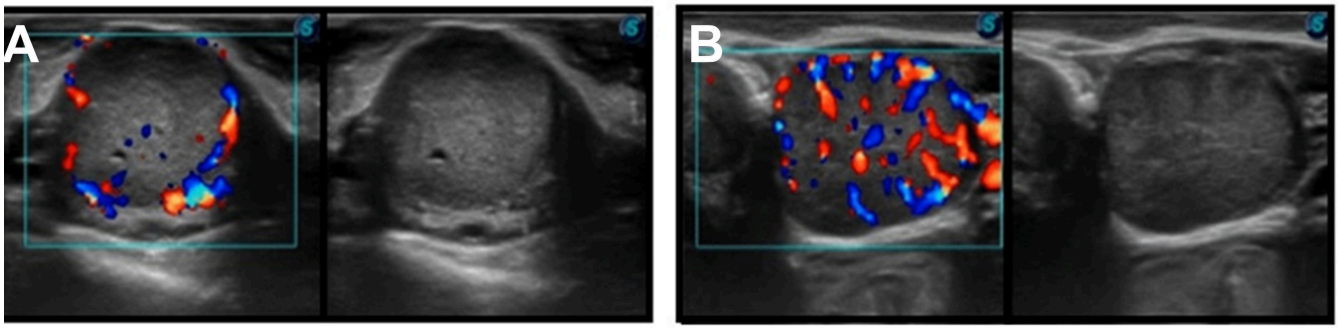

Figure 1. Representative images of two corpora lutea (CL) with similar size and echogenicity but varying blood perfusion. The CL is represented by the gray, circular structure. The colored pixels represent blood perfusion signals within the CL. Notice that the size of the CL is similar in figures A and B. However, the recipient represented in figure B had greater blood perfusion compared with recipient A.

Research overview

Our group collaborated with ET companies and their clients to evaluate the relationship between CL blood perfusion in embryo recipients at the time of transfer and pregnancy rates in embryo transfer programs. A total of 746 postpartum beef cows across Georgia, Texas, and Kansas were enrolled in this study. All recipients were exposed to an industry-standard synchronization protocol (7-d CO-Synch + CIDR), followed by fixed time ET nine days after the intravaginal progesterone device was removed. Estrus expression in response to the synchronization protocol was evaluated. Recipient eligibility to embryo transfer was determined using conventional ultrasonography. Immediately before ET, we

used color Doppler ultrasonography to estimate the percentage of the CL area with blood perfusion and categorized recipients into three groups: low (≤ 30%), medium (>30 to ≤ 40%), and high (> 40%) blood perfusion. Cows were also classified by CL size: small (< 2.5 cm²), medium (2.5 to 3.5 cm²), and large (> 3.5 cm²). Pregnancy diagnoses were determined 60 to 90 days after embryo transfer.

Key findings

Estrus expression was observed in 72% of cows, and cows that expressed estrus had greater (P = 0.02) pregnancy rates compared with cows that did not express estrus (54% vs. 42%). When analyzing pregnancy rates by CL size (Figure 2.A), no differences (P = 0.50) were observed among small, medium, or large CL categories. There was an impact of CL blood perfusion on pregnancy rates, where cows with medium and high blood perfusion had greater (P < 0.01) pregnancy rates than those with low blood perfusion. Moreover, cows with high blood perfusion tended (P = 0.07) to have greater pregnancy rates compared with cows that had medium blood perfusion (Figure 2.B). Notably, cows that

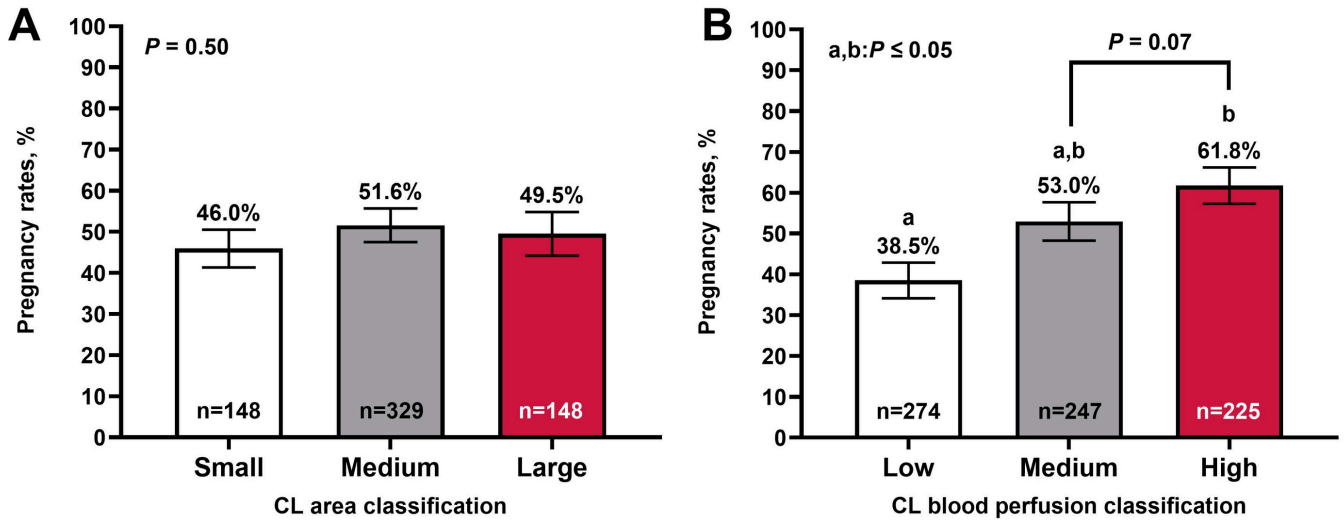

Figure 2. A. Pregnancy rates of embryo transfer recipients based on corpus luteum (CL) area classification. Recipients were grouped into small (<3 cm²), medium (3–4 cm²), or large (>4 cm²) CL categories. B. Pregnancy rates of embryo transfer recipients based on luteal blood perfusion classification. Recipients were categorized as having low (≤ 30%), medium (30 – 40%), or high (> 40%) blood perfusion based on the percentage of the CL with colored signals.

failed to express estrus but had high CL blood perfusion achieved pregnancy rates comparable to cows that expressed estrus (Figure 3). The latter finding highlights the potential use of color Doppler to identify embryo recipients with greater probability of becoming pregnant among non-estrus cows.

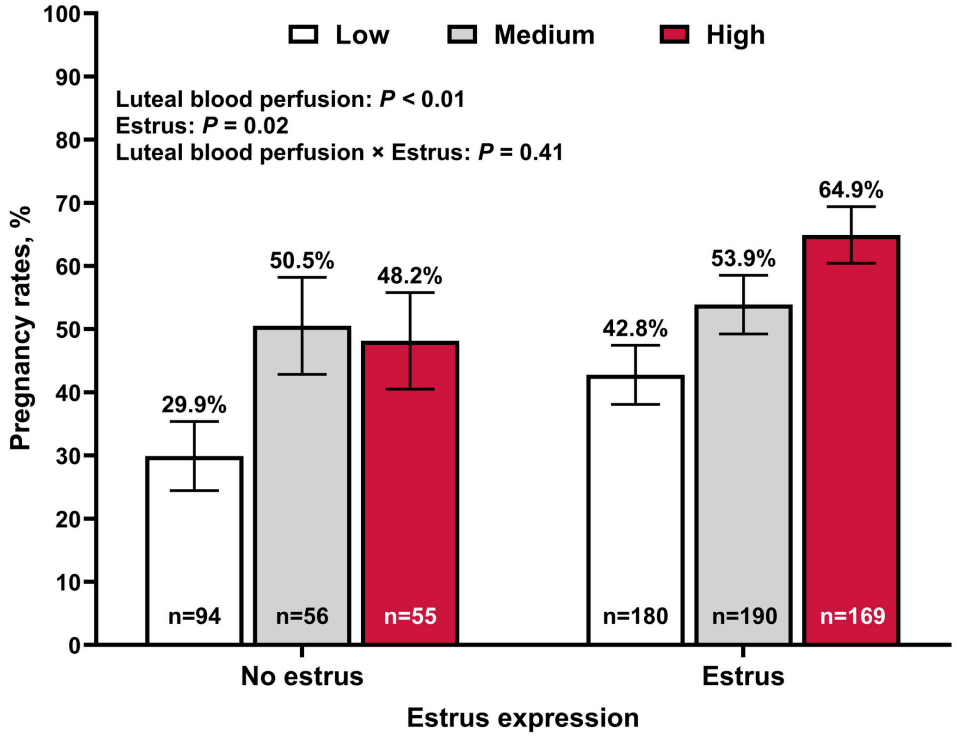

Figure 3. Pregnancy rates categorized by luteal BP [low (≤ 30%), medium (30 – 40%), or high (> 40%)] within estrus expression groups. Data are shown separately for cows that expressed or failed to express estrus.

Practical applications

Incorporating color Doppler into ET programs can help embryologists and seedstock producers optimize embryo recipient selection. In scenarios where more embryos are available than recipients, color Doppler ultrasonography can help allocate higher-value embryos to recipients with high blood perfusion, increasing the chances of generated pregnancies from these genetically superior embryos. Conversely, in situations where the

number of recipients is greater than the number of embryos, color Doppler ultrasonography can be used to identify cows that are more likely to conceive, optimizing the use of the available embryos.

Importance of estrus expression

Estrus expression is another critical factor affecting ET success. Cows that display behavioral estrus before ET typically have greater pregnancy rates due to improved uterine receptivity and luteal function. However, many operations still use recipients who fail to express estrus to maximize the number of embryos transferred during the breeding season. While these cows are less fertile on average, about 70% of them still have a suitable CL and can achieve a viable pregnancy. Our research explored whether color Doppler ultrasonography could help identify high-potential recipients among cows that failed or did not express estrus. Color Doppler ultrasonography provided a strategic advantage for selecting non-estrus recipients by identifying cows with adequate probability of pregnancy within this group of females that are generally less fertile.

Conclusion

Our findings indicate the potential of color Doppler ultrasonography to further improve recipient selection in embryo transfer programs. By evaluating blood perfusion within the CL, this technology offers further insight into embryo recipient fertility and serves as an additional resource to facilitate embryo recipient selection.

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