Use of Doppler in bovine reproduction

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Introduction

In the last five years, discussion on the use of Doppler ultrasonography in bovine reproduction has intensified. What until a few years ago was mostly a research technique is now beginning to be utilized more as a technique at the service of the field veterinarian. However, there is still a long way to go before it can be fully established as a routine technique. Today, Doppler ultrasonography can be used to improve the quality of some services, but certainly much more research and development could be done in the near future to cement its use in practice.

The technique uses the Doppler effect, originally described by Christian Johan Doppler in 1842, who discovered how to determine the speed and direction of blood flow. When a sound source and a reflecting source move towards each other, the sound waves compress and are received at a higher frequency than when they were emitted, whereas when the sound source and reflecting source move away, the sound waves dilate and are received at a lower frequency than when they were emitted. This principle is usually summarised by the example of the ambulance siren, whose intensity increases when approaching and decreases when receding. Let's imagine applying the same principle to red blood cells moving within blood vessels. In the case of arteries, they move closer to the ultrasound probe, and in the case of veins, they move further away from the ultrasound probe. Obviously in this case we have to consider other factors; the variation in returned frequency is directly proportional not only to the speed of the blood flow and the original transmission frequency, but also to the speed of propagation of the sound in the tissues and the angle of incidence of the ultrasound beam with respect to the longitudinal axis of the vessel. I say this not to complicate things, but to make it clear that the quality of the image produced by Doppler ultrasonography is the result of various factors, and to a very large extent, the quality of the ultrasound unit used. We could conclude by saying that not all Doppler ultrasonographic machines are of quality.

Where can I apply Doppler ultrasonography?

- Today, Doppler ultrasonography can be used for the diagnosis of non-pregnancy. This is probably the most consistently and widely used application.

The use of Doppler ultrasonography makes it possible to make an indirect assessment of the level of progesterone produced, this being directly proportional to the vascularisation of the corpus luteum (Luteal Blood Flow). The smaller the area of vascularisation of the CL, the lower the level of progesterone. An inseminated, non-pregnant cow will have progesterone levels close to 1.0 ng/ml (day 18-19 post AI), or below 1.0 ng/ml (days 20-22 post AI) between days 18 to 23 after AI. The identification of a CL with peripheral vascularisation < 25% and central vascularisation < 10% allows us to say that the cow is not pregnant. However, for higher values of vascularisation, it is not possible to say that the cow is pregnant, as one of the following situations may occur:

1. Presence of sub-clinical endometritis with persistent CL.
2. Existence of cattle with a longer than normal luteal phase (>14 days).
3. Presence of cows with three follicular waves:

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in these cows, the indirect determination of progesterone on day 18– 19 post AI risks finding elevated progesterone levels even in non-pregnant cows.

4. Embryo death: If the embryo dies after day 13 -14 post AI, progesterone descent is delayed, such that at day 18-19 post AI, there is still a risk of finding progesterone levels > 1.0 ng/ml.

   Today, the diagnosis of non-pregnancy by Doppler ultrasonography is based on a score of 0-4. Cows with score 0-1 have corpora lutea with peripheral vascularisation < 25% and central vascularisation < 10%; these are cows that will certainly not be pregnant. Cows with score 3-4 have peripheral vascularisation > 40% and central vascularisation > 15%; they could be pregnant. The problem is score 2 cows, i.e. with peripheral vascularisation of 25-35% and central vascularisation of 10-15%, where to say if they are definitely not pregnant is honestly a risk.

- Doppler ultrasonograhy can also be used to make a differential diagnosis between a CL and a luteinised follicular structure. This is useful in the case of super ovulated cows, which despite the abundant presence of luteal tissue on the ovaries on the day of flushing, have not produced any embryos.

- Recently, the use of Doppler ultrasonography to select recipients for embryo transfer has also been proposed.

Table 1: Relationship between corpus luteum age, level of progesterone produced and corpus luteum surface vascularisation (LBF) From O.J.Ginther 2007

Application in beef cattle

The problem with dairy cows is re-synchronisation. The systematic application of an intra-vaginal device to all cows inseminated after a Double Ovsynch/Pre-Synch is either impossible or not convenient, and the re-synchronisation model used for beef cows does not work in dairy cows. However, this is a a surmountable problem. The real bottleneck in practice is the application of the intra-vaginal device on all cows.
Assume that we still want to make a diagnosis of non-pregnancy by Doppler ultrasonography; to know at day 19 -20 post AI that the cow is certainly non-pregnant. What are the potential advantages? Considering the follicular map of the dairy cow on day 19-20, we cannot administer a prostaglandin, because the CL will be atretic. Alternatively, if we start an Ovsynch

Day	P4 ng/ml	LBF cm2q
4	1.7	0.3
7	4.0	0.7
14	7.3	1.3
16	7.1	1.2
17	5.4	1.0
18	2.7	0.7
19	0.8	0.2
20	0.6	0.1
21	0.5	0.1

Pic. Scanning with Easi-Scan:Go and wireless goggles BUG goggle.

protocol instead, with fixed time insemination on day 29-30, the conception rates that can be obtained will be much lower than 20%. However, Doppler ultrasonography could be used in small-medium sized farms where synchronisation is not used, to evaluate cows not seen in oestrus between the 23rd and 25th day after insemination, thus diagnosing cows that are certainly not pregnant.

The Future

Doppler ultrasonography can justifiably be described as an open construction site. The possibilities offered by this technique are currently limited to the diagnosis of non-pregnancy, but in the short and medium term, other services could be developed, such as assessment of the embryo donor and recipient, assessment of the time of ovulation, and assessment of the state of suffering of the embryo.
Already in the short term, it will be possible to self-set the Doppler instrument and, probably thanks to artificial intelligence, directly calculate the level of progesterone, which corresponds to the degree of vascularisation of the corpus luteum.
The quality of the ultrasound unit remains one of the most important points to consider.