The benefits of real-time ultrasonography for early pregnancy diagnosis

Sows that are non-pregnant or non-lactating decrease the reproductive efficiency of pig operations as they generate production costs, mainly related to feeding, and occupy space in gestation facilities without producing pigs. This precludes profit due to failure to cover accumulated costs associated with their daily maintenance and housing.

by Carlos H.C. Viana, Veterinarian, Doctor in Animal Reproduction, Adjunct Professor, Pontifícia Universidade Católica de Minas Gerais, Poços de Caldas, MG and Diego F. Leal, Veterinarian, Master in Animal Reproduction, Doctor Student at the Animal Reproduction Department, Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo, Pirassununga, SP. www.imv-imaging.com

The application of effective methods for early determination of pregnancy status is an important component of reproductive management programmes because it allows producers to remove, treat or rebreed sows that fail to become pregnant in a timely fashion, thereby reducing the number of non-productive days.

In pig breeding operations, pregnancy diagnosis has traditionally been performed by exposing sows daily to a sexually mature boar from day 17-23 following insemination, and absence of signs of standing oestrus around this period is indicative of pregnancy.

Nevertheless, a number of factors may influence this methodology, including delayed return to oestrus following breeding, ovulation in the absence of oestrus behaviour, cystic ovaries, and errors in oestrus detection by farm personnel. Moreover, daily detection of behavioural oestrus is labour intensive and time consuming.

Other methodologies for pregnancy diagnosis such as determination of oestrone sulphate or progesterone concentrations, vaginal biopsy, and laparoscopy can all be used for pregnancy diagnosis in pigs, notwithstanding the fact that their application as an on-farm tool is limited due to practical constraints.

Additionally, amplitude mode (A-mode) and Doppler sonography cannot be used accurately to confirm pregnancy status before day 28 of gestation.

In this context, real-time ultrasonography (RTU) is a potential tool to increase reproductive efficiency of an operation. Of note, trans-abdominal RTU can be used reliably for troubleshooting reproductive dysfunction, monitoring follicular dynamics and ovulation, confirming the attainment of puberty, diagnosing uterine and ovarian pathological conditions, embryonic death and abortion, and for early assessment of pregnancy status.

With respect to the latter, the overall accuracy of the examination – which is determined by sensitivity (ability to detect pregnant animals) and specificity (ability to detect non-pregnant animals) – is largely influenced by stage of pregnancy.

Pregnancy diagnosis

Pregnancy diagnosis in pigs can be performed via the transrectal or transcutaneous routes.

Transcutaneous RTU is preferentially used for pregnancy diagnosis because it is readily accessible and quicker to perform.

To visualise the gravid uterus, the transducer should be placed on the lower abdomen above the mammary glands in the inguinal area, just lateral to the nipple line and cranial to the hind leg. The transducer should be pointed towards the spine, forming a 45-degree angle and directed dorsocaudally and dorsocranially.

Ultrasound gel or lubricant must be applied to the transducer surface in order to maximise wave propagation and contact between the skin and the transducer. Both the 3.5 and 5.0MHz transducers can be used for pregnancy diagnosis; however, according to Kauffold et al. (2019), if a single transducer frequency should be selected, 5MHz is preferred as lower frequencies typically provide for lower resolution.

	Days post-insemination					
	17	18	19	20	21	Total
Positive	36	28	40	53	40	197
Negative	12	1	5	16	8	42
False +	16	7	3	0	0	26
False -	34	10	3	0	0	47
Total	98	46	51	69	48	312
Sensitivity	51.43	73.68	93.02	100.00	100.00	-
Specificity	42.86	12.50	62.50	100.00	100.00	-
Accuracy	48.98	63.04	88.24	100.00	100.00	-
PPV	69.23	80.00	93.02	100.00	100.00	-
NPV	26.09	9.09	62.50	100.00	100.00	-

PPV, positive predictive value; NPV, negative predictive values

Table 1. Sensitivity (%), specificity (%), overall accuracy (%) and predictive values (%) of pregnancy diagnosis from day 17-21 post-insemination.

The non-gravid uterus is characterised by circles (cross-section of uterine horns) of moderate echogenicity. The non-gravid uterus, in turn, is more difficult to visualise, which poses a challenge for the inexperienced operator to rule out pregnancy. The visualisation of multiple fluid-filled pockets within the uterus, representing the embryonic vesicles, can be considered as the first sign of pregnancy.

Embryonic vesicles, measuring from 10-20mm, can easily be visualised on day 20 of pregnancy (Fig. 1). After day 21 of pregnancy the embryos can be observed. Embryos are represented by echogenic structures within the vesicles.

Around day 30 of pregnancy it is possible to distinguish the head, the abdomen, and the limbs of the embryos (Fig. 1). From day 60 it is possible to visualise the ocular orbits, the spine and the beating foetal heart, which is indicative of foetal viability.

As mentioned above, RTU for pregnancy diagnosis is advantageous when compared to other methodologies, because not only can conception failure be early detected but also putative causes of reproductive pathologies can be identified. This would give pig producers reliable information on whether a sow should be treated, re-inseminated or culled.

Another possible use of RTU is to diagnose 'late fallouts', i.e., sows that were considered pregnant but who fail to farrow.

Spotting these pregnancy failures is of great importance to reduce non-productive days, since open sows will remain in the gestation facility, being identified only in the farrowing unit.

Early diagnosis of pregnancy by trans-abdominal RTU using a portable scanner

Numerous studies have demonstrated that overall accuracy, sensitivity and specificity of trans-abdominal sonography examination increase as pregnancy progresses. However, there is still a large amount of variation among trials on the precise stage of pregnancy in which an accurate diagnosis can be made.

Moreover, the majority of trials have been carried out under controlled conditions using non-

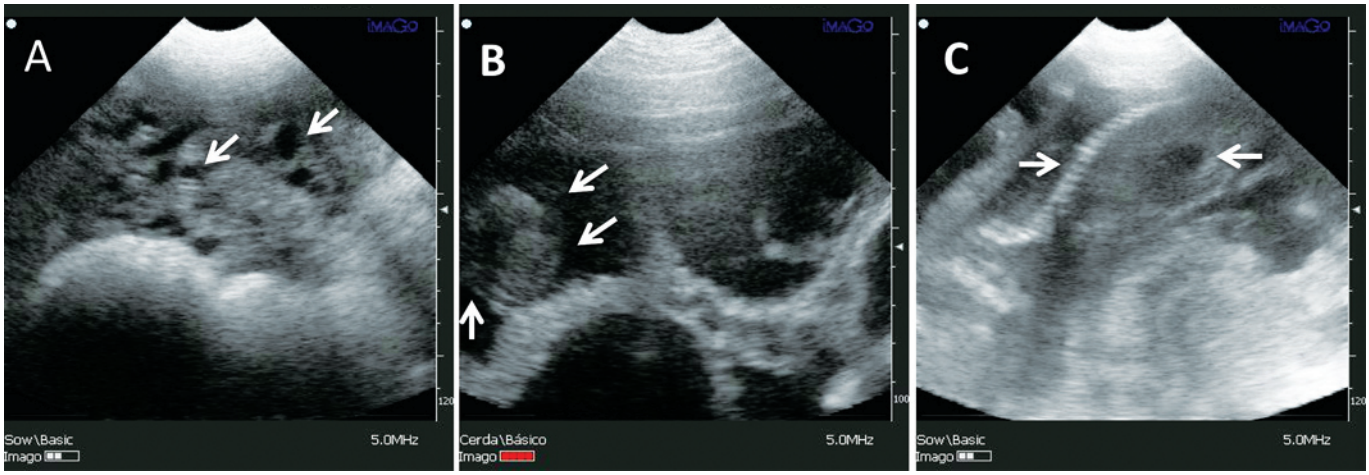


Fig. 1. Transcutaneous RTU imaging of the gravid uterus. Day 20 of pregnancy (A), multiple embryonic vesicles (arrows); around day 35 of pregnancy (B), the head, the abdomen, and the limbs of the embryos can be differentiated (arrows); ›90 days of pregnancy (C), the stomach, the rib cage and the spine of the embryos can be seen (arrows).

portable ultrasound machines. Portability, long battery-life, ease of cleaning, externally disinfectability, and robustness are desirable characteristics of an ultrasound scanner to allow its extensive use for pregnancy diagnosis in commercial pig operations.

Therefore, a trial was conducted to evaluate the accuracy and the predictive values of trans-abdominal ultrasonography for early pregnancy diagnosis using a portable compact battery-operated ultrasound machine under field conditions. To achieve this objective, a total of 312 examinations were performed.

Pregnancy checks were carried out daily from day 17-21 post-insemination using a portable scanner with 5 MHz sector transducer (ImaGo.S, IMV imaging). The last insemination was considered as day 0 of pregnancy.

A positive pregnancy result was considered when fluid-filled pockets representing the embryonic vesicles could be observed. Accuracy was defined as the number of sows whose pregnancy status (either pregnant or non-pregnant) was diagnosed correctly/total number of sows diagnosed.

Sensitivity was defined as the number of pregnant sows diagnosed correctly/total number of sows diagnosed as pregnant. Specificity was defined as the number of non-pregnant sows diagnosed correctly/total number of females diagnosed as non-pregnant.

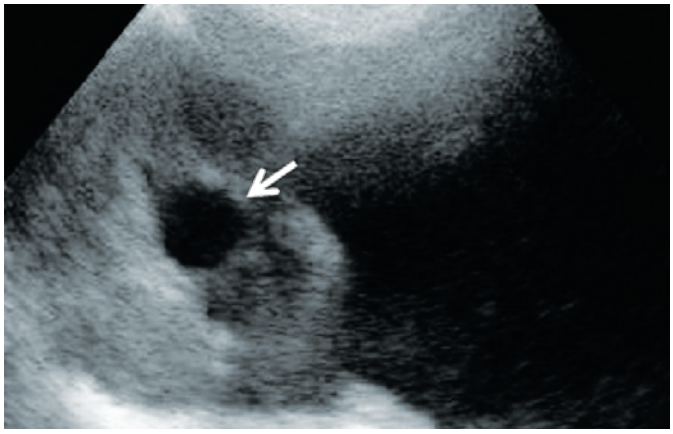
The outcome of an additional examination on day 28 post-insemination was used as the gold standard to establish pregnancy status. Predictive values for positive (PPV) or negative testing (NPV) were calculated on every day of the study. Uncertain results were considered as negative.

The outcomes of testing at various days post-insemination are shown in Table 1. In summary, sensitivity and overall accuracy was low on day 17 post-insemination, increasing rapidly from day 19 onwards. Overall accuracy reached its highest value on day 20, and the majority of errors occurred between days 17-19 post-insemination.

These results demonstrate that pregnancy can be diagnosed as early as day 17 post-breeding using a compact ultrasound scanner; notwithstanding the fact that the accuracy of testing at this early stage of pregnancy remains low. In contrast, from day 20 onwards the accuracy rate reached 100%. This disagrees with previous studies in which the accuracy of testing was greater than 95% from day 22. Of note, the PPV and NPV reached 100% on day 20, meaning that sows with a negative or positive result will not need to be tested later.

In conclusion, pregnancy can be diagnosed reliably and with high accuracy on day 20 post-insemination under field conditions using a portable scanner.

Fig. 2. Transcutaneous RTU imaging of an ovarian cyst (arrow).



Using RTU for troubleshooting reproductive dysfunction

In modern pig production it is estimated that as many as 40-50% of breeding females are culled each year; of these, 30% are culled by third parity, reproductive failure being one of the major reasons for involuntary culling of low parity sows.

It should be pointed out that decreased sow longevity is not only an economic burden for the pig industry but also results in poor animal welfare. To maximise profitability, sows should be retained in the breeding herd up to parity six since higher parity dams wean numerically more and heavier piglets per year when compared to first and second parity sows.

In commercial operations, there is a lack of proper assessment of the actual reproductive status of breeding sows which results in unnecessary culling. In this sense, RTU can be used as a diagnostic tool to substantiate the decision for culling. In this context, ovarian cystic degeneration can affect 10% of sows in a herd, being an important cause of reproductive failure.

Using RTU ovarian cysts can be readily identified, avoiding economic losses and the unnecessary culling. Ovarian cysts can be easily identified with both 3.5MHz and 5MHz transducers. They appear as fluid-filled ovarian structures (Fig. 2) measuring more than 12mm and can be classified as follicular or luteal cysts.

Metritis is another uterine condition that can be diagnosed using RTU. The echographic image of affected sows shows heterogeneous echogenic material inside an enlarged uterine lumen. Of particular note, some sows may not have vulvar discharge as a sign of uterine infection; these cases can only be quickly identified through RTU imaging.

Closing remarks

The intensive application of technological tools has become a hallmark of pig production; in this sense, including RTU as part of the reproductive management of pig operations has become almost mandatory. RTU is an invaluable technological tool to aid in the process of decision making on pig farms.

Using RTU, it becomes possible to examine the reproductive tract of sows with reproductive disorders and an accurate decision can be made either to remove the sow or to implement correction measures. This is of particular importance for young sows which are removed from the breeding herd chiefly for reproductive failure, increasing sow retention.

Finally, it should be emphasised that the technique of RTU does not increase reproductive efficiency and correct management deficiencies per se; it is how the information gathered is interpreted and implemented on the farm that will count. ■

References are available from the author on request