Foetal sex determination by ultrasonography

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Foetal sex determination can be a valuable tool on modern-day dairy farms. It was first described using ultrasonography by Müller and Wittkowski in 1986. At this time it was carried out between days 70 and 120 of pregnancy by looking for the male scrotum or female mammary teats, a method now known as late foetal sex determination.

Early foetal sex determination was not described until 1989, by Curran et al., and was carried out between days 55 and 65 of pregnancy by determining the location of the genital tubercle. This article aims not only to discuss how foetal sex determination can be carried out using ultrasonography, but also to discuss why it is such a valuable tool.

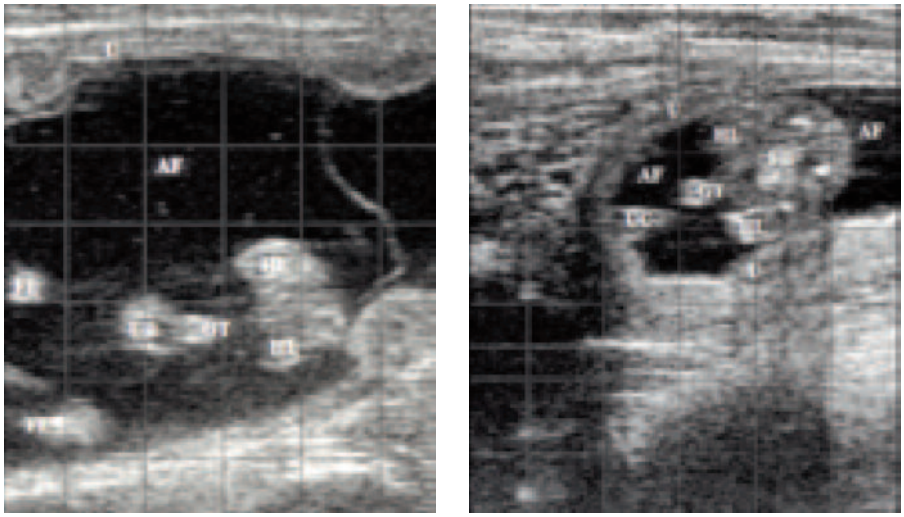


Fig. 1. Left, ultrasound image of a male foetus at 65 days of gestation seen in the frontal plane and, right, ultrasound image of a male foetus at 55 days of gestation seen in the transverse plane. Visible structures include: uterus (U), amniotic fluid (AF), umbilical cord (UC), foetal body (FB), forelimbs (FL), umbilicus (UB), hindlimbs (HL) and genital tubercle (GT). All images were obtained using an Easi-Scan, BCF Technology (linear rectal probe; 4.5-8.5 MHz; ovary/early mode).

Early determination

As mentioned, early foetal sex determination is carried out by determining the location of the genital tubercle. The genital tubercle forms from the cloaca during embryonic development and gives rise to the penis and prepuce in the male and to the vulva and clitoris in the female.

It is initially located between the hindlimbs in both sexes, but after day 50 of pregnancy it begins to migrate towards the umbilicus in the male foetus and towards the tail root in the female foetus.

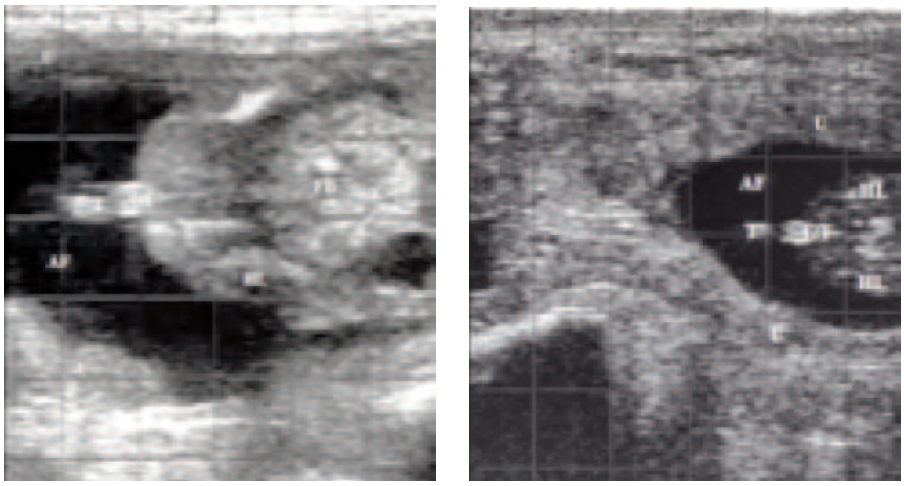
Early foetal sex determination is generally carried out between days 55 and 65 of pregnancy. On day 55 the genital tubercle is located halfway between its initial and final positions, but by day 60 it has reached its final position, caudal to the umbilicus (see Fig. 1) in the male foetus and just under the tail (see Fig. 2) in the female foetus.

The genital tubercle appears as a bilobular, ovoid structure, which is a few millimetres in size and highly echogenic. Tainturier et al. (2004) liken it to an equal symbol (=).

The genital tubercle is best visualised in either the frontal or transverse plane. In the frontal plane both possible locations can be visualised at once. In the transverse plane the foetal head should be visualised first and then the probe should be moved caudally from head to tail to ensure both possible locations are visualised in turn.

Additionally, in the male foetus three highly echogenic lines may be seen close to the genital tubercle, signifying the scrotal sac (see Fig. 3).

Fig. 2. Left, ultrasound image of a female foetus at 65 days of gestation seen in the frontal plane and, right, ultrasound image of a female foetus at 55 days of gestation seen in the transverse plane. Visible structures include: uterus (U), amniotic fluid (AF), foetal body (FB), hindlimbs (HL), tail (T) and genital tubercle (GT).



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Between days 70 and 75 of pregnancy the genital tubercle in the male foetus becomes hypoechogenic as it forms the penis and is therefore difficult to visualise on ultrasound, making this method of foetal sex determination less useful.

A study by Tainturier et al. in 2004 found that early foetal sex determination using ultrasonography is both accurate and safe. They concluded that the average success rate for 107 foetal sex diagnoses carried out between days 54 and 69 of pregnancy was 81%, although the success rate for the more certain diagnoses was 92%.

They also found that success rate was significantly higher after day 60 of pregnancy when the genital tubercle has reached its final position. The abortion rate of the cows in the study was found to be 2%, which corresponded to the expected abortion rate of cows at the time. It is important to remember that these rates will depend on the skill of the operator.

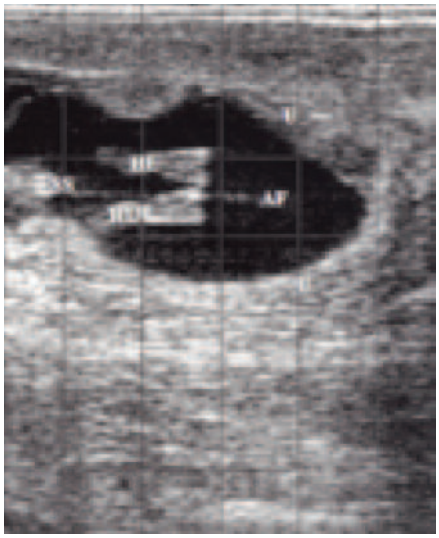

Fig. 3. Ultrasound image of a male foetus at 55 days of gestation seen in the transverse plane. Visible structures include: uterus (U), amniotic fluid (AF), hindlimbs (HL) and scrotal sac (SS).

Late determination

Although early foetal sex determination is generally favoured, late foetal sex determination can be useful if the time window for early sex determination has passed. Late foetal sex determination is carried out by visualising the scrotum in the male foetus or the mammary teats in the female foetus.

Late foetal sex determination is generally carried out between days 80 and 100 of pregnancy. The scrotum can be visualised between the hindlimbs of the male foetus in the transverse plane (see Fig. 4), although care must be taken not to confuse it with the umbilical cord, which should be visualised as a separate structure to prevent confusion.

The mammary teats can be visualised in the inguinal region of the female foetus in the frontal plane and appear as four highly echogenic dots arranged in a square.

To carry out late foetal sex determination the foetus should be visualised first in the transverse plane, to check for the presence of a scrotum, and then in the frontal plane, to check for the presence of mammary teats. Identification of the mammary teats can be difficult so determining the location of the genital tubercle is more reliable when determining female foetal sex.

Fig. 5 summarises at what stages of gestation early and late foetal sex determination can be carried out. Foetal sex determination is difficult after day 100 of pregnancy as the foetus lies deeper within the abdominal cavity and its larger size makes it difficult to obtain the required sections.

Modern application

Foetal sex determination can be a valuable tool on modern-day dairy farms for a variety of reasons, although farmers should always be warned that there is a chance that the foetal sex diagnosis could be incorrect.

Firstly, nowadays, many farmers prefer to carry out pregnancy diagnosis early at 30 days instead of the traditional 42 days as this allows non-pregnant cows to be treated earlier ensuring that they are served again as soon as possible.

Embryo losses between days 28 and 42 of gestation can be as high as 10-15% so there is a risk that early pregnancy diagnosis could miss late embryonic/foetal death if cows are not rechecked or observed for return to oestrus. When foetal sexing is carried out cows receive a second ultrasound examination so late embryonic/ foetal death is more likely to be detected.

Fig. 4. Ultrasound image of a male foetus at 80 days of gestation seen in the transverse plane. Visible structures include: uterus (U), amniotic fluid (AF), hindlimbs (HL) and scrotal sac (SS).

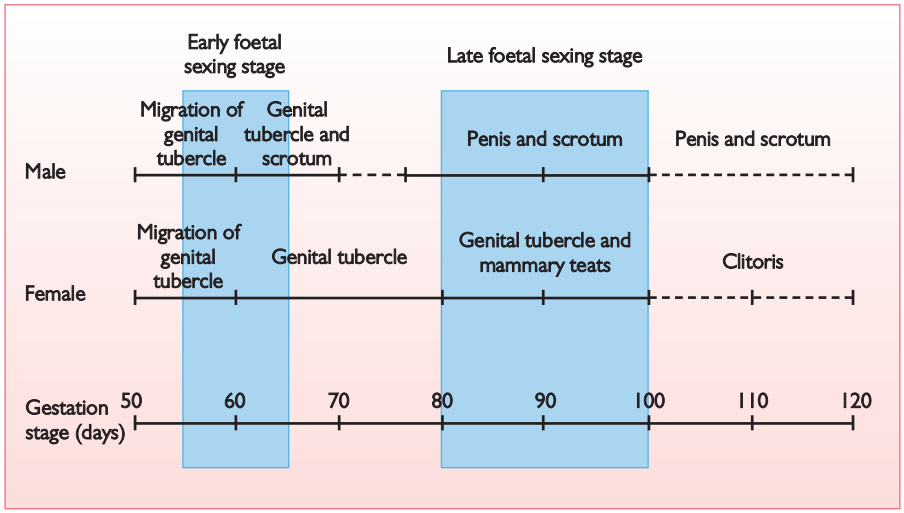

Fig. 5. Diagram summarising at which stages of gestation early and late foetal sex determination can be carried out (adapted from Tainturier et al. 2004).

Knowledge of the foetal sex can help when making a decision about the fate of a cow. A farmer may be more inclined to keep a cow carrying a female foetus instead of selling her or sending her for slaughter, not only because a dairy heifer calf would be more valuable than a dairy bull calf, but also because replacement heifers may be in short supply.

Knowing the sex of foetus a pregnant cow intended for sale is carrying could be useful as a cow carrying a female foetus could be more valuable than a cow carrying a male foetus. This is especially true for high value foetuses, for example those resulting from embryo transfer.

When dizygotic twins are present, knowing the sex of both foetuses makes it possible to predict the likelihood of a sterile freemartin being born if one foetus is male and the other is female. 85-90% of females born to male co-twins are sterile freemartins as anastomosis of the chorionic blood vessels at an early stage of development in the uterus allows male hormones to inhibit the development of the female reproductive tract.

Knowledge of the foetal sex may be helpful to farmers when faced with a difficult calving. If the cow is known to be carrying a male dairy calf the farmer may be more inclined to give the cow time to stretch before assisting, reducing the risk of the injury to the cow as in this case the cow is more valuable to him than the calf.

He may also be less likely to consider a caesarean section, for this reason and the fact that a caesarean section may not be economically viable, if an embryotomy could be carried out instead. If the cow is known to be carrying a female dairy calf the farmer may be keener to get the calf out quickly and more likely to consider a caesarean rather than an embryotomy.

Foetal sex is known to be a risk factor for calving difficulty resulting in requirement of assistance. Mee et al. (2011) found that the likelihood of calving difficulty or requirement of assistance was greater for male calves.

This is especially true for heifers and is likely to be due to feto-pelvic disproportion. Foetal sex determination gives farmers the option of inducing animals that are carrying male foetuses, especially if they are small-sized heifers, to reduce the risk of calving difficulty or requirement of assistance.

However, when considering induction it is important to remember that it can predispose to calving difficulties, as a result of foetal malpresentation, and post-calving problems, for example retained foetal membranes. Farmers should always be warned of these risks.

Finally, foetal sex determination will give the farmer an idea of the number of replacements likely to be available well before calving occurs. This will allow him to plan culling or heifer sales in advance and to purchase additional animals when available if required.

There is currently a short supply of dairy replacements for sale in the UK, so knowing in advance how many animals he will need to purchase allows a farmer to keep an eye out for potential good lots in advance, avoiding the need to panic buy. It also gives him the option of purchasing younger animals to serve himself if in-calf animals are not available.

Conclusion

Foetal sex determination by ultrasonography is both accurate and safe when carried out between days 55 and 65 of pregnancy. Although, knowing how to determine the foetal sex using ultrasonography is an impressive skill to have, veterinary surgeons must also be aware of how it can be applied on farms to bring benefit to them.

Once veterinary surgeons are aware of this and foetal sex determination is in place, it can be a valuable tool on modern-day dairy farms. ■

References are available from the author on request