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Sexing of Boer goat fetuses using transrectal ultrasonography

M.H.B. Santos[1], R.T.D. Moura[1], R.M. Chaves, A.T. Soares[2], J.P. Neves[3]
H.D. Reichenbach[4], P.F. Lima[1], M.A.L. Oliveira[1,5]

[1]Laboratório de Biotécnicas da Reprodução, Departamento de Medicina Veterinária, Universidade Federal Rural de Pernambuco, 52171-900 Recife, PE, Brazil.
[2] Empresa Estadual de Pesquisa e Agropecuária da Paraíba S/A, 58013 290 João Pessoa, PB, Brazil.
[3]Faculdade de Agronomia e Medicina Veterinária, Universidade de Brasília, Brasília, DF, Brazil.
[4]Bayerische Landesanstalt für Landwirtschaft/LfL, 85586 Poing-OT/Grub, Germany.

Abstract

The goal of this study was to determine the ideal period for sexing Boer goat fetuses using transrectal ultrasonography. The objective of Experiment 1 was to diagnose the sex of fetuses based on the final position of the genital tubercle (GT) through a series of daily exams between Days 40 and 60 of pregnancy. The objective of Experiment 2 was to evaluate the accuracy of fetal sexing with a single exam conducted between Days 45 and 60 of pregnancy. The transrectal exams were conducted using a dual-frequency, linear-array transducer (6.0 and 8.0 MHz). In Experiment 1, 61 fetuses were monitored at 24-hour intervals between Days 40 and 60 while 47 fetuses were examined only once between Days 45 and 60 in Experiment 2. The accuracy of fetal sexing in Experiment 1 was 100% (8/8) for single pregnancies, 96.9% (31/32) for twin pregnancies, and 100% (21/21) for triplet pregnancies. In Experiment 2, the accuracy was 94.4% (17/18) for single pregnancies, 80.8% (21/26) for twin pregnancies, and 100% (3/3) for triplet pregnancies. There was no difference in accuracy between the distinct type of pregnancy and between the two experiments (98.3% and 87.2% for Experiment 1 and 2, respectively). The GT migration occurred between 43 and 54 days of pregnancy (mean = 47.4 ± 6.5 days). In conclusion, the use of ultrasound for sexing goat fetuses is a suitable and accurate method based on the final location of the GT and the identification of external genitalia from Day 55 of pregnancy onwards. Daily exams do not increase the accuracy of fetal sexing diagnosis in Boer goats.

Keywords: fetus, genital tubercle, goat, sexing, ultrasound.

Introduction

Raising goats in Brazil has increased in recent years due to the introduction of exotic species, especially in the northeastern region where the concentration of these animals is the highest (Anuário Estatístico do Brasil, 2002). The Boer breed, which originated in Africa and is meat-type goat, has high productivity and reproductive performance. Importation of animals, semen, and embryos has been intensified to enhance the existing native goat herds in Brazil (Lobo and Vilella, 2005; Vilella *et al*., 2005). This new trend has started a transition from a subsistence-based animal husbandry model to a more demanding and technically advanced system in which the adoption of reproductive technologies intensifies the husbandry of goats and assures the turnover of the invested capital (Bandeira *et al*., 2004).

Early diagnosis of pregnancy and fetal sexing using ultrasonography enhances reproductive management on farms and improves the commerce of pregnant animals (Reichenbach *et al*., 2004; Santos *et al*., 2004). Fetal gender identification, mainly in goats, is a technique hardly diffused throughout the world compared to cattle (Curran, 1992; Stroud, 1996), horses (Merkt and Moura, 2000), and sheep (Coughbrough and Castell, 1998; Bürstel *et al*., 2001; 2002; Bürstel, 2002; Andrade *et al*., 2004, Santos *et al*., 2005b; Santos *et al*., 2006). In Brazil, research has been stimulated regarding the sexing of fetuses in small ruminants, especially goats (Oliveira *et al*., 2005; Santos *et al*., 2005b).

Multiple pregnancies in goats often decreases the accuracy of fetal sexing with a single ultrasound examination (Bürstel, 2002; Oliveira *et al*., 2005; Santos *et al*., 2005a; b). Another factor that has to be considered in order to increase the accuracy of sexing goat fetuses is the determination of a suitable period during gestation to perform the procedure taking into consideration time of completion of genital tubercle (GT) migration. Defining this period in these animals will improve the use of fetal sexing for either scientific or commercial goals (Santos *et al*., 2005a).

The goal of this study was to establish the ideal period for sexing Boer fetuses using transrectal ultrasonography. The objective of Experiment 1 was to diagnose the sex of fetuses based on the final position of the GT through a series of daily exams between Days 40 and 60 of pregnancy. The objective of Experiment 2 was to evaluate the accuracy of fetal sexing with a single exam conducted between Days 45 and 60. This study used 108 Boer fetuses from which

[5]Corresponding author: maloufrpe@uol.com.br
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Materials and Methods

61 were derived from natural mating and 47 from embryo transfer. All females were mated only once, and the day of mating was considered Day 0 of pregnancy. The embryos were recovered on Day 7 and transferred immediately after the collection.

Transrectal ultrasonography, performed by the same experienced technician, of animals in a standing position was carried out using a 240 Parus (Pie Medical, Maastricht - Netherlands) ultrasound scanner equipped with a dual-frequency, linear-array transducer (6.0 and 8.0 MHz) that was fixed to a PVC support to facilitate manipulation of the transducer inside the animal's rectum as suggested by Oliveira *et al*. (2004). Still images from ultrasound examinations were printed using a Seikosha VP/1200 printer (Sony, Tokyo - Japan). To perform the exam, females had their rectums manually evacuated and an ultrasonic coupling gel was applied to the transducer before its introduction into the rectum.

In Experiment 1, after insertion of the transducer into the rectum and having located the fetus, a scanning technique for fetal sexing was established. Determination of the sex was based on the identification and location of the GT relative to the location of umbilical cord attachment or tail or by identification of other external genitalia from different scanning planes according to Moura (1993). The fetuses were diagnosed as a male when the GT was located immediately caudal to the umbilical cord or as female when the GT was positioned directly below the tail (Fig. 1).

In Experiment 1, 61 fetuses were monitored daily between Days 40 and 60, and the sex was diagnosed based on the location of the GT. In Experiment 2, 47 fetuses were examined only once between Days 45 and 60, and the sex was identified using the location of the GT or any anatomical structure of external genitalia (Fig. 1). In the last week of pregnancy, the females were transferred to individual pens to confirm the sex of fetuses immediately after birth.

The results were analyzed by the chi-square test using a significance level of $P < 0.05$.

Table 1. Fetal sexing of Boer goat fetuses by daily ultrasonographic monitoring between 40 and 60 days of pregnancy. Experiment I.

Type of pregnancy	Correctly sexed fetuses (n)	Unsexed fetuses (n)	Live kid (n)	Accuracy of diagnosis n (%)
Single	8	0	8	8/8 (100.0)
Twin	31	1	32	31/32 (96.9)
Triplet	21	0	21	21/21(100.0)
Total	60	1	61	60/61 (98.3)

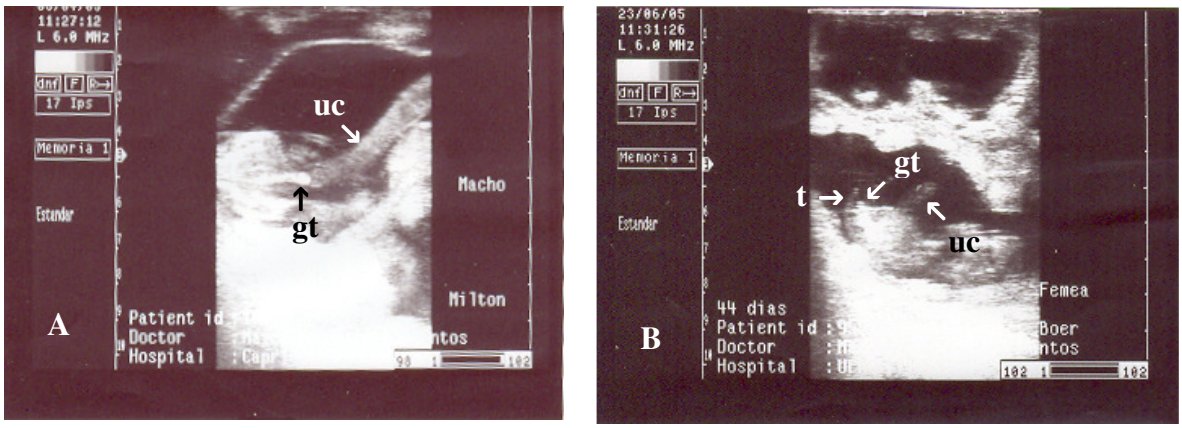

Figure 1. Ultrasound images of a male fetus (A) showing the genital tubercle (gt) located immediately caudal to the umbilical cord (uc) and of a female fetus (B) highlighting the genital tubercle (gt) in close proximity to the tail (t).

Results

In Experiment 1, 8 females had a single fetus while 23 had multiple fetuses of which 16 had twin and 7 had triplet pregnancies. No differences were detected in the accuracy of fetal sexing among the different types of pregnancies (Table 1). The identification of fetal sex by location of the GT varied from Day 43 to 54 (Fig. 2) with a mean of Day 47.4 ± 2.5. For most of the fetuses (53/61), the GT migration was completed between Days 43 and 50. For some fetuses (8/61), completion of GT migration occurred after Day 50 of pregnancy.

In Experiment 2, 18 females had single pregnancies and 14 had multiple pregnancies of which

13 were twin and 1 was a triplet pregnancy. Similar to Experiment 1, there were no differences in the accuracy of fetal sexing among the different types of pregnancies examined (Table 2). From the 47 fetuses of Experiment 2, 5 were sexed on Day 45, 19 on Day 51, 9 on Day 54 and 8 on Day 60 of pregnancy. For 6 fetuses, the sex was unable to be identified in 5, attempts on Day 51 and 1 on Day 60.

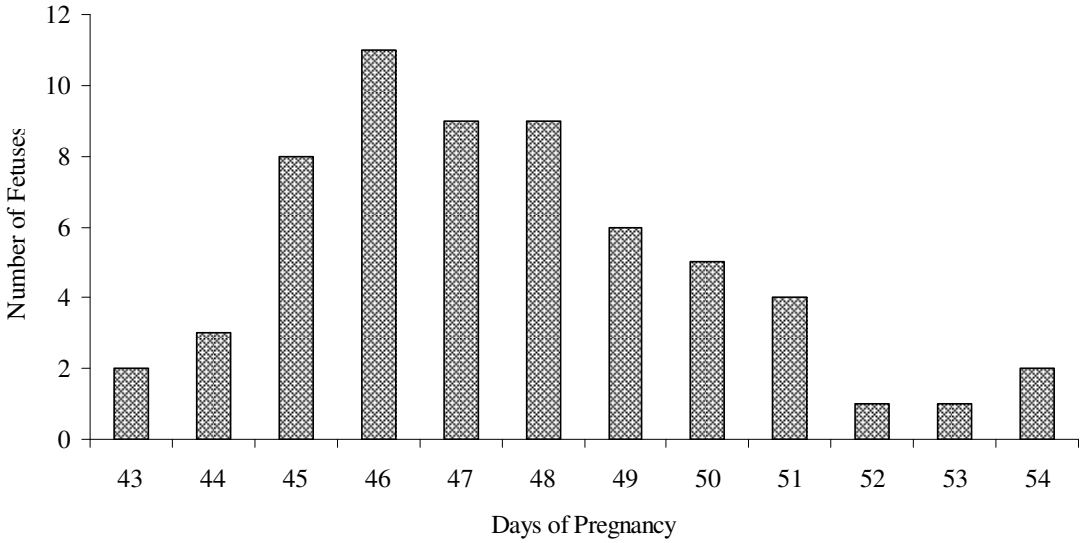

Figure 2. Day of pregnancy when migration of genital tubercle was complete in Boer goat fetuses.

Table 2. Fetal sexing of Boer goat fetuses with a single ultrasound examination between 45 and 60 days of pregnancy. Experiment 2.

Type of pregnancy	Correctly sexed fetuses (n)	Unsexed fetuses (n)	Live kid (n)	Accuracy of diagnosis n (%)
Single	17	1	18	17/18(94.4)
Twin	21	5	26	21/26 (80.8)
Triplet	3	0	3	3/3 (100.0)
Total	41	6	47	41/47 (87.2)

Discussion

In this study, the period for fetal sexing based on the final position of GT did not differ from those found by Oliveira *et al*. (2005) and Santos *et al*. (2005b) for other goat breeds. Even though the GT migration was completed by Day 50 for most fetuses (78.7%), it is important to emphasize that the migration occurred after this day in a considerable number of fetuses (21.3%). This supports the recommendation of Santos *et al*. (2005a) to begin sexing of goat fetuses only after Day 55 of pregnancy due to the wide range of time of completion of GT migration.

It is important to mention that the GT of some fetuses may complete migration after Day 55. A few studies, which determined the timing of GT migration in sheep (Santos *et al*., 2005b, Santos *et al*., 2006) and goats (Oliveira *et al*., 2005), indicate that the timing of GT migration differs among species, animals of the same or different breeds, and fetuses of the same pregnancy.

Fetal sexing demands a skilled technician and use of adequate ultrasound equipment to allow a quick and accurate diagnosis. This recommendation is particularly important for female fetuses because the final location of the GT is relatively close to its initial position. For this reason, there are incorrect diagnoses; however, this can be reduced by a later exam that allows the visualization of the GT in its final position or identification of other structures of external genitalia.

The biggest challenge of fetal sexing using ultrasound in small ruminants compared to horses and cattle that affects accuracy of the diagnosis is the decreased ability to manipulate the uterus during the examination in small ruminants. Repeated ultrasound examinations of the same animal are required to accurately identify the fetal gender, as suggested by Bürstel (2002) and Reichenbach *et al*. (2004). However, in this study where the accuracy of fetal sexing was similar to that of Santos *et al*. (2005a,b; 2006) and Oliveira *et al*. (2005), repeated exams at short intervals did not improve the accuracy of fetal sex determination.

Furthermore, exams done at short intervals are less feasible in the field because they can increase expenses. This could threaten the use of the technique that, if well managed, could maximize not only animal husbandry and commercial planning of the property as reported by Haibel (1990) and Reichenbach *et al*. (2004), but also animal productivity.

Dependent on the day of pregnancy and the number of fetuses, it is not always possible to quantify all fetuses in multiple pregnancies or even identify gender of all fetuses during a single exam. This observation agrees with Reichenbach *et al*. (2004) who, besides using more sophisticated equipment and skilled technicians, recommended serial exams for multiple pregnancies.

The initial expectation for differences in the accuracy of fetal sex determination between single and multiple pregnancies (especially in triplets) was not confirmed in this study. The most difficult pregnancy for fetal sexing is the multiple pregnancy, which is in agreement with White *et al*. (1984), Gearhart *et al*. (1988), and Haibel (1990) as well as with Bürstel *et al*. (2001), who proposed exams be conducted during two consecutive periods, Days 50 and 56 and Days 66 and 70. The latter authors recommend multiple exams for fetal sexing restricted to triplet pregnancies because the presence of more fetuses increases the risk of failures in diagnoses. This opinion is shared by White *et al*. (1984), Gearhart *et al*. (1988), Haibel (1990), Oliveira *et al*. (2005), and Santos *et al*. (2005b; 2006).

The accuracy of fetal sexing, mainly in Experiment 2, was similar to that found by Oliveira *et al*. (2005) and Santos *et al*. (2005b). On the other hand, it disagrees with Bürstel *et al*. (2002), who does not recommend this examination for multiple pregnancies. The better results of this work, when compared to those obtained by Coughbrough and Castell (1998) and Bürstel (2002), should be attributed to the quality of the ultrasound apparatus. The dual frequency of the linear-array transducer, the enlargement of images, the possibility of retrieving images produced in the last 30 seconds of the exam, and freezing images to get a better detail were important to the success of fetal sexing.

The results of this experiment show that real-time ultrasound scanning is an accurate method for sexing Boer fetuses from Day 55 of pregnancy onwards either by locating the GT or by identifying external genitalia. Repeated scanning at short intervals did not increase the accuracy of fetal sex diagnosis in this species.

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