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Fetal growth monitoring using ultrasonographic assessment of femur and tibia in Sahelian goats

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1 ABSTRACT

The fetal growth monitoring using ultrasonic assessment of tibia (TL) and femur (FL) with known gestational stage (GS) were obtained from Twenty-one (21) gravid Sahelian goat, performed twice-weekly using ultrasound machine having 5 MHz linear transducer. The fetal ages ranged between day 30 and day 120. The data were fitted to their optimal regression line ($p < 0.05$) and described by the equation as well as coefficient of determination was calculated. The threshold of accurate ultrasonic femur and tibia measurement in Sahelian goat is approximately days 43, with respectively 10.83 mm and 6.2 mm. The derived gestational stage prediction equations were GS = 0.66TL – 21.09, (r=0.93) and GS = 0.59FL – 21.59, (r=0.92), where GS is in days, FL and TL are in mm. These results suggest that, FL and TL can be used to estimate GS in Sahelian goats. The study also shows that, in many aspects, growth changes in femur and tibia had very similar patterns in goats and sheep, indicating their close phylogenic relationship.

2 INTRODUCTION

The development of a method to accurately estimate the stage of pregnancy when precise mating dates are not available, would assist management to maximize survival rates of offspring (Greenwood *et al*., 2002). In goats, fetal growth monitoring has been attempted using direct ultrasonic assessment of fetal parameters. The fetal bones used in those studies were BPD (Haibel, 1988; Reichle and Haibel, 1991), CRL (Haibel, 1988; Karen *et al*., 2009) ONL and OD (Nwaogu *et al*., 2010). In sheep and human, those parameters were extended to the femur (Hadlock *et al*., 1983; Vural *et al*., 2008), tibia (Goldstein *et al*., 1988) humerus (Jeanty *et al*., 1984; Vural *et al*., 2008) and metacarpus lengths (Greenwood, 2002). However, in goats there was a lack of information on the assessment of fetal growth pattern, particularly tibia and femur. The reported relationships between GS and femoral and humerus lengths in Saanen and balady goats were ranged from middle to late stage of gestation (Karen *et al*., 2009; Abdelgafar *et al*., 2012). Concerning tropical domestic breed, there is paucity of information on the suitability of this technique for use in Sahelian goat (Zongo *et al*., 2014). Furthermore, it admitted that further improvement in predictive capacity was achieved by using many criteria and developing multiple regression equations from measurement of both bones (Sivachelvan *et al*., 1996; Greenwood, 2002). The present study reports and discusses the use of real-time ultrasound to assess fetal growth through femur and tibia monitoring in order to predict the stage of pregnancy in

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Sahelian goats and underlines the similarity or difference in developmental pattern comparing to ewes.

3 MATERIALS AND METHODS

This study was undertaken at the station of University Ouaga I Professor Joseph KI - ZERBO from November 2016 to May 2017. Twenty-one nulliparous Sahelian goats ranging in age and weight from 12-15 months and 35-40 kg respectively, were synchronized using a day's 12 chronogest® CR treatment with intravaginal sponges containing 20 mg of flurogestone acetate (FGA, Intervet International B.V., Intervet Ireland Ltd, Intervet productions S.A., Rue de Lyons, France) (Doizé *et al.*, 1997). They were mated during the induced oestrous with a fertile buck wearing marking harnesses (raddled marks were recorded Day 0) and presented day 25 later for pregnancy diagnosis. Following determination of pregnancy, longitudinal images of fetal hind limbs bones, which included bones extremities, were frozen on the screen and measured using internal electronic callipers. The does in standing position, was examined twice a week until day 120 using RTU with a 5 MHz linear-array transducer. Data of this study fitted to their optimal regression line ($p < 0.05$) and described by the equation as well as coefficient of determination was calculated.

4 RESULTS

The gestational sac was first observed, which presents itself as an anechoic structure and spherical, on day 25 post mating (Figure 1).

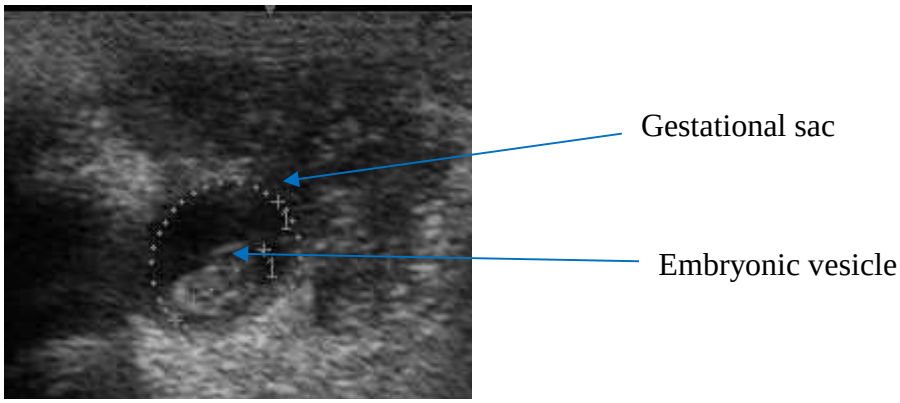

Figure 1: ultrasonic image of day 25 embryonic vesicle of Sahelian goat

The embryo is not well-defined ultrasonographicaly until day 34, where the head and body were visible and measured 13.55 ± 8.49 mm of diameter and 20.51 ± 1.35 mm of length respectively. The first measurement of tibia and femur lengths occurred on day 43, with respectively 10.83 mm and 6.2 mm (Figure 2).

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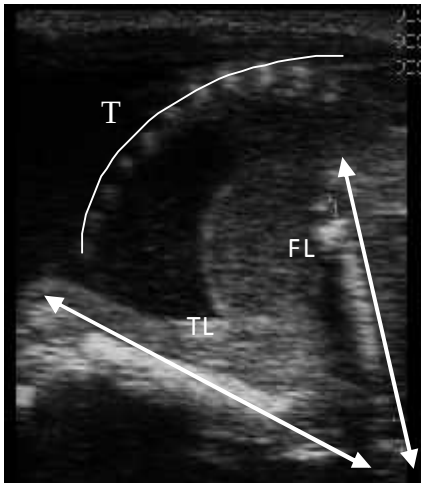

Figure 1: Ultrasonographic image of a day 78 fetal hind limbs showing longitudinal bones (FL=23.70 mm, TL= 37.59 mm) and tail.

The scatter plots and regression lines for mean TL and FL are depicted in Figure 3 and 4.

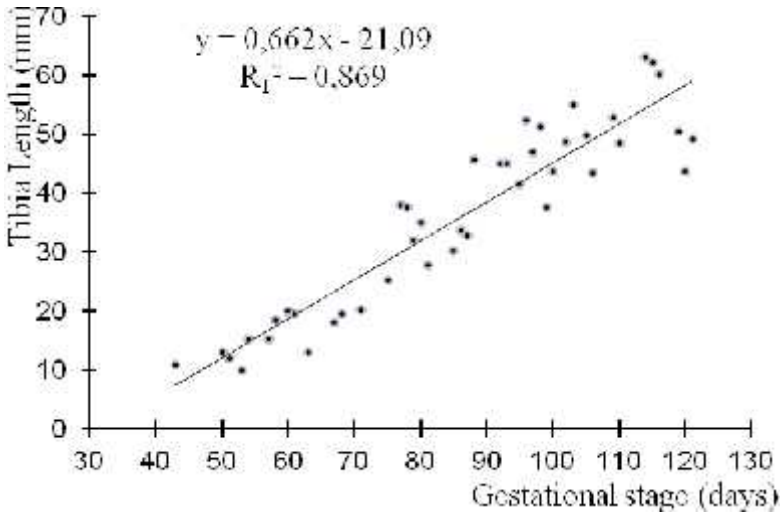

Figure 3: Mean TL measurements and regression line from day 43 to day 120 of gestation for 43 observations in 21 goat foetuses.

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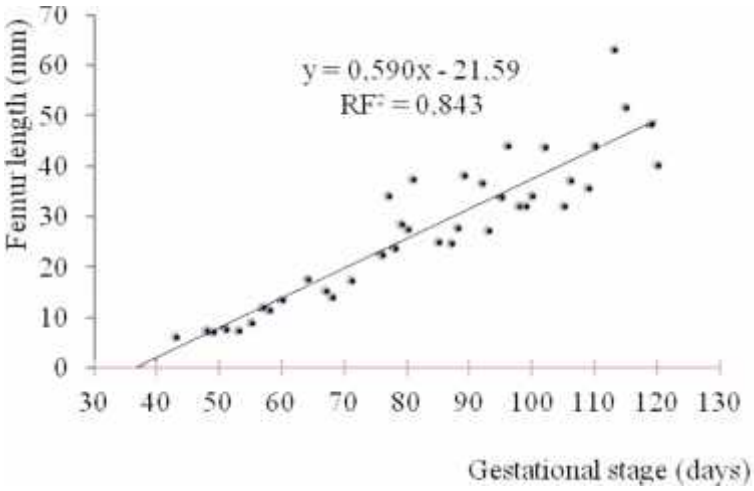

Figure 4: Mean FL measurements and regression line from day 43 to day 120 of gestation for 39 observations in 21 goat foetuses.

The relationship between GS (in days) and TL (in mm) is described by the equations: [GS = 0.66TL – 21.09]. The coefficient of correlation (R_T) equalled 93%. The similar relationship between GS and FL is [GS = 0.59FL – 21.59] with R_F = 92%.Results of the present study showed that fetal tibia and femur were significantly correlated with gestational age ($P<0.01$). All included does showed normal gestation and delivery. Repeated exposure of foetuses to ultrasonography waves did not cause any abnormalities in the off spring and all foetuses were born apparently healthy.

5 DISCUSSION

In previous studies, fetal growth based on parameters measurements has not been adequately covered for farm animals (Jainudeen and Hafez, 1980). Apparently, no previous work has followed fetal hind limbs bones growth in goats as has been done in the present study. However, the previous data available for sheep (Sivuchelvan *et al.*, 1996; Vural *et al.*, 2008) and goats (Haibel, 1988), using specimens with known ages, formed a useful basis in formulating the chronological guide provided here.The threshold of accurate ultrasonic femur and tibia measurement in Sahelian goats using a 5 MHz linear array transducer is approximately day 40. Examination for FL and TL measurement at earlier stages of gestation may affect the clear identification of a longitudinal fetal hind limbs bones image.These findings are in close agreement with those reported in akkaraman ewes (Vural *et al.*, 2008). However, in Saanen goats and European ewes, the femur identification and measurement were delayed at 50 and 61 days post breeding, respectively (Gonzalez-Bulnes *et al.*, 1998; Abdelghafar *et al.*, 2012). The variability regarding the threshold of accurate ultrasonic femur measurements may result from differences in methods. The measurements in this study started earlier at day 30 of gestation. In this study, all ultrasonography measurements exhibited linear increase as correlated with the advancement of pregnancy. The high rate of growth of the fetal hind limbs bones was demonstrated by the high significant correlations (r_F = 0.92; r_T = 0.93) between those bones and GA. These observations were consistent with previously reported studies in Akkaraman ewes (Vural *et al.*, 2008). In that ewes breed, the tibia and femur growth highly

correlated with the advancement of pregnancy as 97% and 79% respectively. The correlation coefficient is an indicator of the strength of the linear relationship between the GS and the parameters. From the growth curves, it can be observed that all the points seem to lie near a line indicating that the relationship between gestational stage and the parameters are all linear. The closer the scattered points are to the best line of fit, the higher the proportion of the total variation in the data that is explained or accounted for by the regression model. Accurate linear regression has also been established in domestic sheep (Noia *et al.*, 2002) and wild sheep (Santiago-Moreno *et al.*, 2005) using measurements of the femur. Observations on relative growth parameters as well as growth pattern, equations, coefficients of correlation of tibia and femur for goat and sheep foetuses indicated that these two variables bear a very strong linear relationship and that body size changes in goats and sheep depict a similar isometric proportionate growth pattern (caprine, GS= 0,66TL - 21,09, R_T = 0.93 and GS = 0.59FL – 21.59, R_F=0.92; ovine, GS = 0.55TL – 19.843, R_T = 0.97; GS = 0.25 FL + 12.37) (Vural *et al.*, 2008). This would mean that goats and sheep maintain a similar body shape and form. It could be summarized from observations in the present study and those of previous researchers that bones are expected to follow the same time-event and sequence in both sheep and goats with almost the same average length of gestation (Jainudeen and Hafez, 1980; Sivuchelvan *et al.*, 1996).

6 CONCLUSION

This study reported that the threshold of accurate ultrasonic femur and tibia measurement in Sahelian goat using a 5 MHz linear array transducer is day 43, with respectively 10.83 mm and 6.2 mm. Moreover, ultrasonography monitoring of fetal growth using tibia and femur measurements were an appropriate and useful technique to estimate the GS between gestation day 30 and 120 in Sahelian goats.The study also showed that, in many aspects, sequential changes in developmental features as well as growth changes in hind limbs long bones had very similar patterns in sheep and goats, indicating their close phylogenic relationship.

7 LIST OF ABBREVIATION

gs: gestational stage, FL: femoral length, TL: tibia length, MHz: mega hertz, Ouaga I JKZ: Ouaga I professor Joseph Ki Zerbo

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