Prediction of Gestational Age by Transabdominal Real-Time Ultrasonographic Measurements in Saanen Goats (*Capra hircus*)

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Abstract: The main objective of the present study was to predict gestational age of Saanen goats by real-time ultrasonography utilizing measurements of Crown Rump Length (CRL), Bi Parietal Diameter (BPD) and Umbilical Cord Diameter (UCD). Transabdominal ultrasonography was carried out on 38 goats that became pregnant after estrous detection and artificial insemination. Measurements were taken between week (5-10), (6-23) and (7-23) for measuring the CRL, BPD and UCD, respectively. Results clearly demonstrated that CRL, BPD and UCD were significantly correlated with gestational age (P<0.01). The BPD was strongly positively correlated with gestational age (R^2=0.91) followed by the CRL (R^2=0.90) and the UCD (R^2=0.87). In conclusion, Results from the present study revealed that the three biometric parameters (CRL, BPD and UCD) were reliable indices to predict gestational age in Saanen goats.

Key words: Ultrasonography · Gestational age · Saanen · Crown Rump Length · Bi Parietal Diameter · Umbilical Cord Diameter

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 off spring [1]. Real-time ultrasound evaluation of small ruminants offers an unparallel range of information regarding pregnancy status, number of fetuses and gestational age [2]. The CRL has been measured in goats [3-5], sheep [6, 7], muskoxen [8], sika deer [9] and reindeer [10]. BPD was measured in domestic goats [3, 4, 11-15], domestic sheep [1, 6, 7, 16, 17], spotted hyenas [18], muskoxen [8], llamas and alpacas [19], sika deer [9], buffaloes [20], bottlenosed dolphin [21], baboons [22] and wild sheep [23]. UCD was measured in goats [4, 11, 12] and in dairy cows [24]. The main aim of the present study was to construct reference gestational equations in Saanen goats using CRL, BPD and UCD. In the Sudan there was only one study reporting ultrasonic fetometry in goats utilizing CRL

(32-67) days and BPD (46-95) days [3]. To the authors' knowledge this is the first study to report measurements of BPD and UCD throughout gestational period in Saanen goats.

MATERIALS AND METHODS

The study was carried out during the period November 2008 to April 2009 at Khartoum Livestock Genetics Improvement Center, Ministry of Agriculture, Animal Wealth and Irrigation, Khartoum State. All procedures were performed with the approval of the General Directorate of Animal Wealth, Ministry of Agriculture, Animal Wealth and Irrigation, Khartoum state. Data were obtained from 38 Saanen goats (1-5 years and weighing between 23-60 kg), that became pregnant after careful observation of estrus and artificial insemination using fresh semen collected from a proven fertile buck. The date of insemination would be probably day 0 of gestation.

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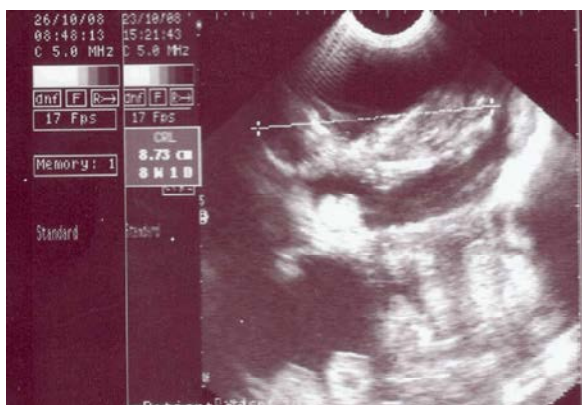Khartoum North, Sudan. E-mail: rehabeen@yahoo.co.uk.

Fig. 1a: Crown-Rump Length measuring 8.73 cm at day 57 of gestation
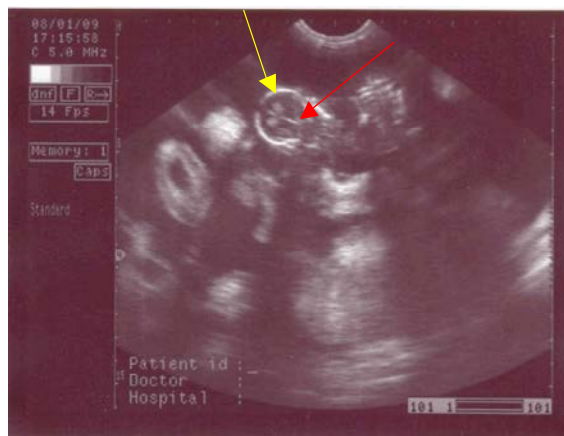

Fig. 2a: Bi Parietal Diameter at day 60 of gestation

Fig. 1b: Crown-Rump Length measuring 7.17 cm in two phases (day 53 of gestation)

Fig. 2b: Bi Parietal Diameter at day 105 of gestation

Does were fed Abu 70 *ad libitum* and a mixture of (sesame cake, groundnut cake, wheat bran and sorghum) as a concentrate ration; however the goats had free access to water and minerals blocks supplements.

Animal Preparation: Animals were kept off food for 12 hours prior to the scanning. The ventral abdomen was clipped and shaved carefully using manual clippers (Super-Max, Green, Feltham TW13 7LR London UK). Sufficient amount of ultrasonic gel (Aquasonic, Parker Laboratories, INC, Fairfield, New Jersey, 07004, USA) was applied to the area prior to scanning. Transabdominal ultrasonography was done using a real-time scanner (Pie Medical, Easote, Holland) equipped with dual frequency (3.5-5) MHz convex transducer and (5-7.5) MHz micro convex transducer while the animal was manually well restrained on a supine position on a specially designed table [25]. Images were stored in a memory card attached to the scanner and later were printed in thermal papers (Sony corporation, type 1, Normal, UPP-110S, 1-7-1,

Konan, Minato-KU, Tokyo, Japan) using video graphic printer UP-895EC (Sony- Japan).

Crown-Rump Length: The CRL was measured weekly between the 5th and 10th week of gestation. The measurements were taken from the most upper part of the skull to the end of the sacrum when the fetus was fully extended (Fig.1a). When the fetus adopted curved position, the measurements were taken in two phases; firstly from the head to the heart area and secondly from the heart area to the sacrum (Fig. 1b)

Bi Parietal Diameter: The BPD was weekly measured starting at week 6- till the end of gestation. The measurements were taken in a coronal section (Fig. 2) with the following criteria. The head was oval in shape as possible, falx cerebri mid line should divided the brain into two similar hemispheres, the posterior horns of the lateral ventricles should be viewed on both sides of the falx cerebri mid line, closed contour of the skull table,
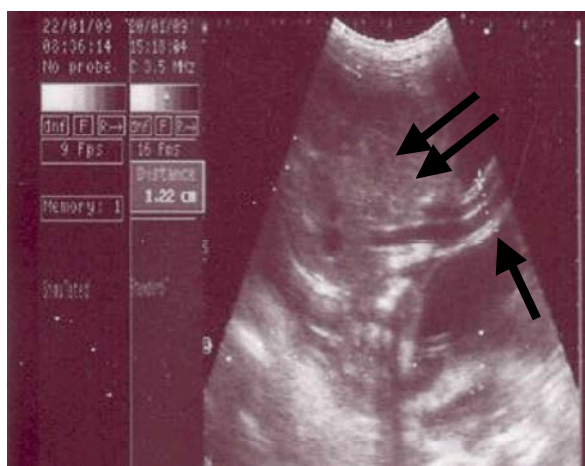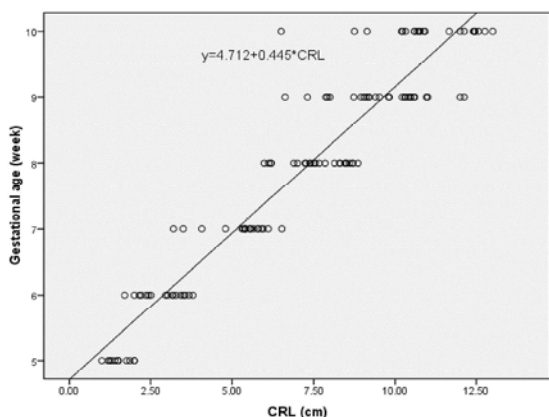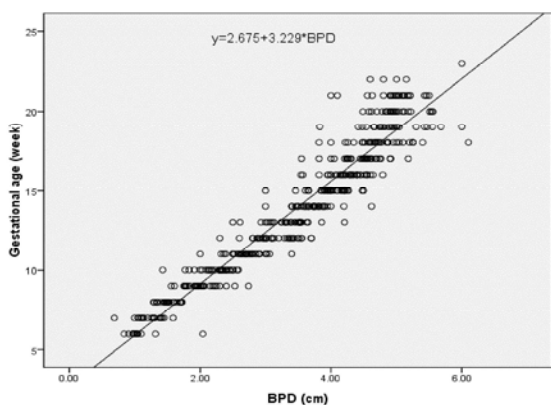
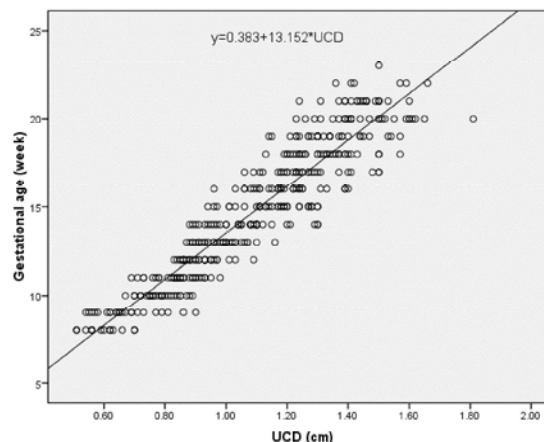Fig. 3: Umbilical cord (Arrow) entering the liver (Double arrows)

* CRL=Crown Rump Length

Fig. 4: Regression curve showing the relationship between the Crown Rump Length (cm) and gestational age (wks) in Saanen goats.

* BPD =Bi Parietal Diameter

Fig. 5: Regression curve showing the relationship between the Bi Parietal Diameter (cm) and gestational age (wks) in Saanen goats.

* UCD = Umbilical Cord Diameter

Fig. 6: Regression curve showing the relationship between the Umbilical Cord Diameter (cm) and gestational age (wks) in Saanen goats.

equithickness of the skull table, measurements were taken from the outer distal calivarium to the inner proximal calivarium

Umbilical Cord Diameter: The UCD was measured in a longitudinal section in any straight part throughout its pathway from the placenta to the liver at weekly intervals starting at week 8 - till the end of gestation (Fig. 3).

The weekly measurements of each fetal parameter was taken (2-3) times when possible and the mean values were utilized for the regression equations.

Statistical Analysis: The relationship between gestational age and each of the three parameters was plotted as linear regression and expressed as straight line equations using Statistical Packages for Social Sciences, (SPSS, Inc. USA). Simple regression equations were established, while the gestational age (Weeks) being the dependent variable (Y) and each fetal parameter measurement (in Centimeters) was considered the independent variable (X). The results were considered significant if p < 0.05.

RESULTS

Results of the present study showed that all the parameters were highly significantly correlated with gestational age (P<0.01). The parameters showing the highest positive correlation with gestational age were the BPD (R^2=0.91) and the CRL (R^2=0.90); however the UCD has shown the least correlation coefficient (R^2=0.87).

Table 1:   Relationship between ultrasonographic measurements of CRL, BPD, UCD and gestational age (GA): Regression equations, correlation coefficient
(R^2) and P-value

Measurement	Equation	R^2	P
Crown Rump Length	$y = 4.712 + 0.445x$	90%	0.01
Bi Parietal Diameter	$y = 2.675 + 3.229x$	91%	0.01
Umbilical Cord Diameter	$y = 0.383 + 13.152x$	87%	0.01

* Y= Gestational age (wks) X= Fetal parameter (Cm)

Simple regression equations, coefficients of determination (R^2) and the p-value were demonstrated (Table, 1). The gestational length in the present study was found to be 146 ± 12 days and all animals maintained good condition throughout the study. Repeated exposure of fetuses to ultrasonic waves did not cause any abnormalities in the off spring and all fetuses were born apparently healthy.

DISCUSSION

To the best of authors' knowledge, this is the first study to report the relationship between the gestational age and Bi Parietal Diameter, Umbilical Cord Diameter throughout the gestational period in Saanen goats. Results of the present study demonstrated clearly that CRL, BPD and UCD were reliable parameters to predict gestational age in Saanen goats. In the present study the CRL had strong positive correlation ($R^2=0.90$). High correlation ($R^2=0.94$) was reported between days 25-70 in the Egyptian Balady goats [4] and between (19-40) days in Anglo-Nubian goats [5]. Decreased correlation in the present study ($R^2=0.90$) in comparison with [4, 5] could be due to long intervals between consecutive scanning, 7 days in the present study versus 3 days in the previous studies and breed differences. The foetal BPD was positively correlated with gestational age ($R^2= 0.91$). [15] reported high correlation ($R^2 = 99.49, 98.75, 97.75$) between days 40-100 of gestation in purebred Toggenburg, purebred Nubian and Angora goats respectively. [14] reported high correlation ($R^2=0.98$) between BPD and gestational age between 39-100 days of gestation in different breed of goats. [13] reported high correlation ($R^2=0.97$) between 36-102 days of gestation in pygmy goats. High correlation in the previous studies compared to our study could probably be due to the fact that the scanning was limited to the 2nd trimester and the intervals between consecutive scanning was short (3-5) days in the previous studies versus 7 days in our study. In our study the scanning extended till the end of gestation; in which in the 3rd trimester foetuses enlarged and the fetal head was compressed by other fetal parts and it could be found anywhere in the abdomen. Breed differences could be a factor. Similar difficulties in measuring BPD in late stages of pregnancy were reported by [18] in spotted hyenas and by [26] in llama. [14, 17] reported that examination of the foetus after the end of the 2nd trimester may become quite time consuming, first with respect to the location of the foetal head which may be anywhere in the abdomen from the inguinal region to the xiphoid; and uterine fluids as proportion to uterine contents now rapidly diminishes and leave the fetal head in an attitude which often defies easy measurements. [11] found low correlation ($R^2=0.81$) between BPD and gestational age in Korean black goats compared to our study; this could be due to long intervals between consecutive examinations; 15 days in the previous study versus 7 days in the present study and also the examination extended to the 3rd trimester. Breed differences could also be a factor. [17] Reported that the threshold of accurate ultrasonic foetal head measurement in sheep is approximately 40 days and examinations for BPD measurements at earlier stages of gestation may affect the clear identification of a symmetrical foetal head image. In the present study the BPD was measured at about 40 days post insemination (wk 6). In the present study the umbilical cord was easily identifiable and was measured at around 50 days of gestation (week 8). The UCD had a strong positive correlation ($R^2=0.87$) with gestational age. [4] found high correlation ($R^2= 0.93$) in Egyptian Balady goats between 30-120 days of gestation. Lower correlation in the present study in comparison with the previous study could be due to the fact that the intervals between the consecutive scanning was long, 7 days in the present study, versus 3-5 days in the previous study. Another factor is that in our study the scanning was carried out till parturition at which time the fetus became very large and occupied the whole uterine lumen, with the umbilical cord becoming so tortuous and accurate measurement was difficult and quite time-consuming. On the other hand much lower correlation ($R^2= 0.71$) was reported by [11] in Korean black goats and ($R^2= 0.77$) by [12] in red Sokoto goats. These differences could be attributed to the differences in intervals of examination (10, 15 days) in the previous studies versus 7 days in our study; also, in our study the scanning extended to the 3rd trimester. Breed differences could also be a factor.

In conclusion, fetometry by real-time ultrasonography was proved to be an efficient and reliable method for predicting gestational age in Saanen goats utilizing Crown Rump Length, Bi Parietal Diameter and Umbilical Cord Diameter

ACKNOWLEDGEMENT

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