

## Ultrasonic Measurements of Crown-Rump Length and Bi Parietal Diameter to Predict Gestational Age in Saanen Goats

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**Abstract:** Four nulliparous pregnant Saanen does of the same age, weight and date of natural mating were involved in this study. Their ages were between 7-31 months; they were housed and managed at the main Center of the Goat Improvement Project, Hilat Kuku, Khartoum State. Estrus was carefully observed and each doe was naturally mated twice in the 1st and 2nd day of estrus, thus the first day of estrus was designated as day 0 of gestation. Ultrasound scanning was done using 3.5 MHz transabdominal convex transducer, from d 46-67 for measuring the Crown-Rump Length (CRL) and from d46-95 for measuring the Bi Parietal diameter (BPD). Gestational equations were established as follows:  $CRL = 0.464x - 17.767$ ;  $BPD = 0.055x - 1.431$  (Where x is the Estimated Gestational Age (EGA) in days. The correlations between the gestational age(x) and each of the two parameters were found to be highly significant ( $p < 0.0001$ ). The CRL was some times difficult to measure due to the fast movement of the fetus; because measurements should be taken when the fetus was fully extended. Measuring the BPD became increasingly difficult as pregnancies advanced beyond d95 (3<sup>rd</sup> trimester).

**Key words:** Ultrasound, fetometry, CRL, BPD, goat

### INTRODUCTION

For over 20 years ultrasound has provided a unique modality for evaluation of pregnancy and establishing gestational age; transabdominal real-time ultrasound has produced exquisite detail of the fetus and a method of documenting fetal motion and viability (Mc Gahan and Coates, 1996).

The application of ultrasound to animals has had a very close relationship to medical applications as shown by the first evaluation publication in the united states in 1956 (Stouffer, 2004). The ultrasonic measurement of (BPD) is routinely done during human prenatal examination, estimation of gestational age by ultrasound was also applied to animals in several studies and in small ruminants during pregnancy, ultrasound derived BPD data have been reported for various breeds of goats, sheep and red deer (Lee *et al.*, 2005).

There are reports of the use of the bi parietal diameter of the skull for the estimation of the gestational age in sheep and goat (Aiumlamai *et al.*, 1992). Gestational age has been estimated during the 2nd and 3rd trimester by ultrasonic fetometry in many species of domestic and non-domestic mammals (Kahn, 1992).

The objective of the present study was to determine the relationship of the gestational age with the measurements of the CRL and BPD using ultrasound techniques and to establish this new technique in veterinary medicine in the country.

### MATERIALS AND METHODS

**Animals:** Four pregnant nulliparous Saanen goats of the same age, weight and date of natural mating were involved in the study. Their ages were between 7-31 months. They were housed and managed at the main center of Goat Improvement Project, Ministry of Agriculture, Animal Resources and Irrigation Hilat kuku, Khartoum State. Estrus was carefully observed and each doe was naturally mated twice on the 1st and 2nd day of estrus, thus the first day of estrus was designated as day 0 of gestation. The experiment extended from July 2005 to March 2006.

**Ultrasound:** Animals were fasted for 14 h prior to the scanning; to avoid accumulation of gases in the gastro intestinal tract which precludes displaying images of high quality. Area of scanning was clipped and shaved

carefully. Animals were layed on their backs (dorsal docubitus) and well restrained, on a flat table; a pillow was used as a cushion to relax the animal. Area of scanning extends from one side of the udder a cross in front of the udder to the other side of the udder and area 20 cm cranial to the udder. All measurements were performed using real-time scanner (FUKUDA DENSHI, JAPAN) with 3.5 MHz extra abdominal convex transducer.

**Crown-Rump Length (CRL):** The scanning was carried out at weekly intervals at d46, 53, 60 and 67 of gestation.

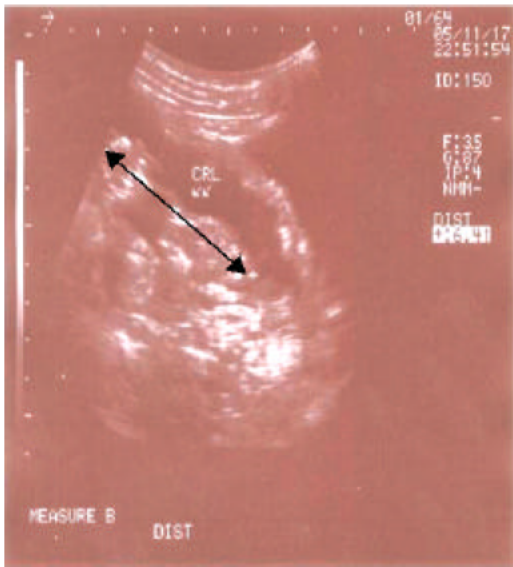


Fig. 1: CRL at day 53 of gestation measuring 6.41 cm



Fig. 2: CRL at day 60 of gestation measuring 9.76 cm (arrow)

The criteria for measuring the CRL in human beings was used. The measurements were taken from the crown

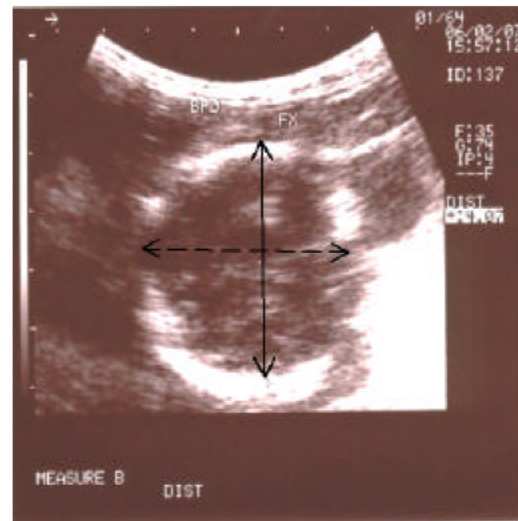


Fig. 3: BPD (complete line) FC midline (dotted line)

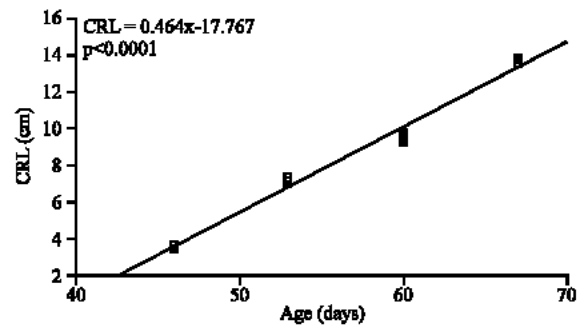


Fig. 4: Showed the relationship between the CRL (cm) and the GA (days)

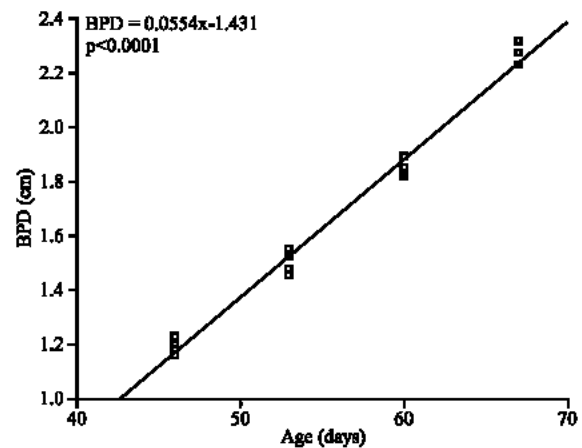


Fig. 5: Showed the relationship between the BPD (cm) and the GA (days)

(most upper part of the skull) to the buttocks (end of the sacrum) when the fetus was fully extended (Fig. 1 and 2).

**Bi Parietal Diameter (BPD):** The scanning was carried out at weekly intervals at d 46, 53, 60, 67, 74, 81, 88 and 95 of gestation

Scanning of the head was done in transverse axial plane as shown in (Fig. 3). The criteria for measuring the BPD was

- Oval shape as possible
- Closed contour of the skull table
- Falx cerebri mid line dividing the hemispheres into two equidistant parts
- Measurements are taken from outer surface of the proximal calvarium to the inner surface of the distal calvarium.

**Statistical analysis:** The data was subjected to linear regression analysis correlation. The relationship between estimated gestational age and each of the ultrasonic parameters (CRL, BPD) were plotted as linear regressions and expressed as straight line equations using SPSS version 11.5 (Gomez and Gomez, 1984) as shown in (Fig. 4 and 5).

**RESULTS**

The measurements for CRL from d 46 to d 67 and for BPD from d 46 to d 95 of gestation were done as shown in Table 1 and 2, respectively

Gestational equations were established for the CRL and BPD as follows.

$$CRL = 0.464 \times - 17.767$$

$$BPD = 0.055 \times - 1.431$$

Where x is the gestational age in days

Table 1: Measurements of (CRL) in Saanen goats

Gestational age (days)	CRL (cm)	Mean±SD
46	3.44	3.59±0.16
	3.45	
	3.75	
	3.70	
53	7.00	7.16±0.20
	7.00	
	7.23	
	7.42	
60	9.78	9.47±0.23
	9.30	
	9.50	
	9.30	
67	13.69	13.65±0.20
	13.50	
	13.50	
	13.91	

Table 2: Measurements of (BPD) in Saanen goats

Gestational age (days)	BPD(cm)	Mean±SD
46	1.16	1.19±0.03
	1.18	
	1.20	
	1.23	
53	1.48	1.51±0.04
	1.55	
	1.46	
	1.53	
60	1.82	1.85±0.03
	1.89	
	1.85	
	1.83	
67	2.23	2.24±0.04
	2.31	
	2.23	
	2.27	
74	2.64	2.70±0.06
	2.68	
	2.67	
	2.79	
81	2.95	3.03±0.12
	3.24	
	2.94	
	3.00	
88	3.34	3.41±0.07
	3.50	
	3.44	
	3.38	
95	3.85	3.92±0.07
	4.00	
	3.89	
	3.95	

The correlation between the gestational age and CRL (Fig. 4) and between BPD and gestational age (Fig. 5) was found to be highly significant (p<0.0001).

**DISCUSSION**

Although ultrasound is commonly used for the measurements of CRL and BPD in pregnant sheep and goats (Aiumlamai *et al.*, 1992; Lee *et al.*, 2005), the study is the first to be conducted in the Sudan. In the present study, CRL and BPD could easily be measured from d 46 to 67 and from d 46 to 95 of gestation respectively and they were found to be highly correlated with gestational age. Santiago-Moreno *et al.* (2005) measured the CRL and BPD from d25 onwards in a mouflon and found a high correlation between the gestational age and each of the two parameters. Similarly high correlation between the gestational age and the BPD was observed in ewes (Aiumlamai *et al.*, 1992) and between d36-102 after mating in pygmy goats (Lee *et al.*, 2005). After d 67 of gestation it was not possible to measure the CRL because the fetus was out of the screen. The BPD was also difficult to measure after d95 of gestation due to the increase in fetal size and compression of the head by other fetal parts. Similar difficulties in measuring the BPD during the late stage was found in llama (Haibel and Fung, 1991) and

during the latter part of pregnancy in ungulate species (Place *et al.*, 2002). Gestational equations derived could be used confidently to estimate gestational period in goats of unknown date of natural mating. In the present study all does were delivered within the normal range of gestation i.e.  $146 \pm 0.6$  days.

In spite of repeated exposure of the fetuses to ultrasonic waves, no fetal deaths or abortions occurred in this study and all kids were born normal and viable. The safety of ultrasound has been reported in similar studies in sheep (Padilla-Rivas *et al.*, 2005).

### CONCLUSION

Real time ultrasonography was found to be a convenient, safe and reliable means of pregnancy detection. It is the only method for determining fetal numbers, sex and prediction of gestational age. Sonographic fetometry in Saanen goat during the 1st and 2nd trimester is efficient for evaluation of fetal development and prediction of calving date.

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