Assessment of gestational age in goats by Real-Time Ultrasound measuring the fetal crown rump length, and bi-parietal diameter

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Summary

The aim of the present study was to specify the relationship of gestational period with measurement of Crown-Rump length and Bi-parietal diameter via trans-abdominal ultrasonography in goats. This study was conducted in the Faculty of Veterinary Medicine in Diyala University. The study was carried out on twelve multiparous does, their ages were between 2-5 years. Does were synchronized for estrus with $PGF_2\alpha$ (Estrumate) at 11 days apart and naturally served to obtain pregnancy (estrus day=day 0), and subsequently Ultrasonic scanned. Weekly ultrasonographic examinations were performed using 3.5-5MHz sector transducer, from week (5-10) and (6-14) of pregnancy for measuring the Crown-Rump length and Bi-parietal diameter, respectively. The results clearly demonstrated that the relationship between gestational age and Crown-Rump length or Bi-parietal diameter were highly significant (P<0.01). The Crown-Rump length was strongly positively correlated with gestational age (R^2=0.99) followed by the Bi-parietal diameter (R^2=0.95). In conclusion, the gestational age of goats can be accurately estimated by trans-abdominal ultrasonography measuring of fetal Crown-Rump length and Bi-parietal diameter during first and second trimester of pregnancy.

Keywords: Ultrasound, Gestation, Crown Rump Length, Bi-Parietal Diameter.

Introduction

Using real-time ultrasound made it possible to study the development and growth of small ruminant fetal organs and parts (Crown-Rump Length, head, eye, stomach, bones and heart) without endangering pregnancy (1-5). Estimation of pregnancy diagnosis and gestational age (GA) are essential for maintenance of high rate of reproduction efficiency (6). The precise estimate of the age of fetus is important for appropriate prenatal management. Whereas the evaluation of GA of fetuses via Real-Time Ultrasound is based on the known relationship fetal age and size of (7). It also provides a valuable tool in selection of animal for increased fecundity and culling of non-production animals (8). The technique of Trans-abdominal ultrasonography has been used with great accuracy as a means for pregnancy diagnosis and estimation of fetal development in sheep (9), goats as in (10 and 11) who reported the relation of bi-parietal diameter, trunk diameter, crown-rump length and uterine diameter with gestational period in the cattle and (7 and 12) reported the change of the Bi-parietal diameter during gestation in sheep and goats, respectively. Gastational age

has been estimated during the 2nd and 3rd trimester by ultrasonic fetometry in many species of domestic and non-domestic mammals (13). Ultrasound measurement of fetal parameters for CRL by using the same approach by (14), who reported a high correlation between the CRL and gestation period.

The aims of the current study were to evaluate the accuracy of fetal measurement (CRL, BPD) measured by real-time ultrasound in order to predict the stage of pregnant does during first and second trimester of gestation.

Materials and Methods

The current study was carried out in the Faculty of Veterinary Medicine-Diyala University last from September-2015 until January-2016. Twelve multiparous goats an average 2-4 years old were used in this study. To detect the pregnancy period, all these does were estrus synchronized by using intravaginal sponges (CHRONOGEST, 20 mg cronolone, Intervet International B.V. Boxmeer, Netherlands) are inserted for 11days and injected intramuscularly with (250 μg)

Alfaglandin-C (Cloprostenol sodium, alfasan, Holland) in the time of insertion. The does were administered 400 IU eCG (FOLLIGON, Intervet International B.V. Boxmeer, Netherlands) 48 hrs, before removal of sponges. The first day of estrus was considered as day 0 of gestation. The Ultrasonographic (U.S) images were obtained by Transabdominal examination was conducted with 3.5-5 MHz convex array transducer, according to (6) using a real-time B-mode scanner (Welld ultrasound, Shenzhen well. D. Medical Electronics Co. LTD. China). Ultrasonographic examination in one week interval for both parameters, started from 5th-10th week for measuring the Crown-Rump Length (CRL) and from 6th-14th week for measuring the Bi-Parietal diameter (BPD). During Real-time ultrasound (RTU) examinations, the doe is usually in a lateral sitting position, the transducer should be placed in the right inguinal region of the female because the rumen displaces the pregnant uterus to the right side and probe abundantly cover with contact gel (15).

Crown-Rump length: Gestational equation was established as follows: GA=4.712 + 0.445 CRL, according to (16). Where the estimated gestational age (EGA) in weeks and CRL was in centimeter. The measurements of CRL were obtained from the greatest upper part of fetal skull to the base of tail when the fetus completely expanded. Least significant difference –LSD test was used to significant compare between gestation period and each of studied parameters. Estimate of correlation coefficient between variables (17)

Bi-parietal diameter: The Gestational equation was established as follows: GA= 21.4 + 1.85 BPD; according to (18) where the gestation period in days and BPL in millimeters. The measurement of BPL, image symmetry is essentially to more accurate measurement. Countenance of both fetal orbits in the same scan is an excellent symmetrical predication mark before freezing the US scan showing maximum diameter of head width (19), meanwhile the measurements of BPD were millimeters.

Results and Discussion

In the current study, the fetal CRL and BPD could easily be measured from week 5- 10 and from 6-14 of gestation, respectively. And they were found to be a relation between ultrasonic measurements (CRL, BPD) and gestation weeks as shown in (Table, 1 and 2) with high significant differences (P<0.01) between weeks of examination in both CRL and BPD. The present study provided an increased development in ultrasonic measurements from 5th-10th week and from 6th-14th week of pregnancy for CRL and BPD, respectively, as appreciably especially during second trimester of pregnancy in both parameters (20 and 21) who observed that the increase fetal growth rate from second to fifth months of gestation. The CRL and BPD ultrasonographic measurements continued in present study until 70 day and 100day of pregnancy, respectively. Beyond this period, they become too long and sizable to be presented efficiently on the scan as a whole (22 and 23). In the current study, it was observed CRL of 22.8 mm in around 5th week of pregnancy which increase to 109mm during 10th week (Fig. 1-4) and (Table, 1).
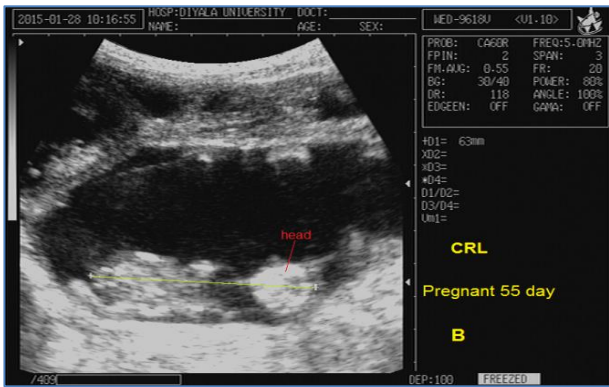
Table, 1: Relationship between gestation age and CRL.

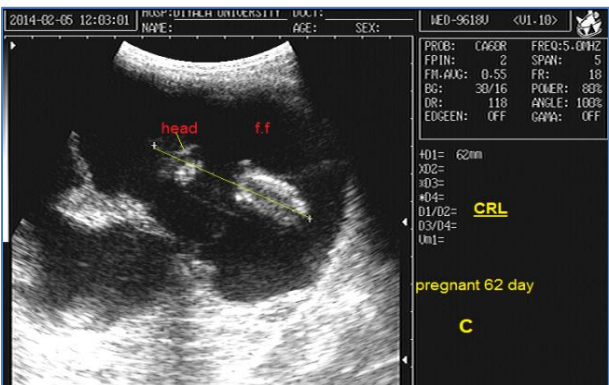| Duration of pregnancy/ week	Crown-RumpLength/ mm
5	22.8
6	29.0
7	48.0
8	56.5
9	64.0
10	109
LSD value	8.916 **
** (P<0.01).	

Figure, 1: Measurement of fetal CRL in 6th week of pregnancy, indicated by straight line, (Sector probe, 5MHz).

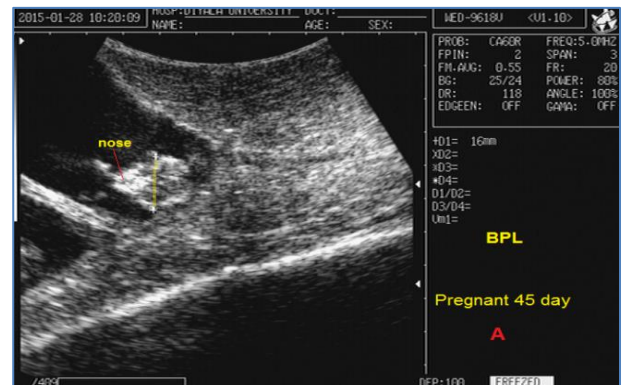**Figure, 2: Measurement of fetal CRL in 8ᵗʰ week of pregnancy, indicated by straight line (Sector probe 5MHz).**

Figure, 3: Measurement of fetal CRL in 9ᵗʰ week of pregnancy, indicated by straight line (Sector probe, 5MHz). f.f: fetal fluid.
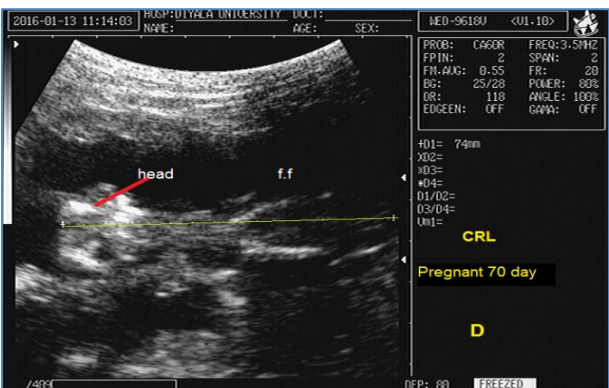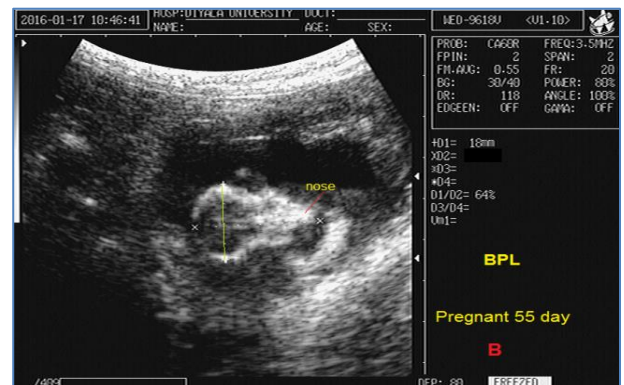

Figure, 4: Measurement of fetal CRL in 10ᵗʰ week of pregnancy, indicated by straight line (Sector probe, 3.5MHz).

These results are similar to findings of (8) who reported fetal CRL of 29.7mm and58.5mm around 40 day and 50day, respectively. Furthermore (24) performed a study on sheep and recording a fetal CRL until day 55 of pregnancy and covenant the present results with the previous data. However, the results of present values on CRL beyond 6ᵗʰ week were lower than that reported by (25). The smaller breed of does used in current study as well as the conditions of ultrasonic examination, may be the causes of this

disparity. Furthermore, the type of pregnancy (single or multiple) it could be an influential factor in the evaluation of fetal CRL (26) particularly after 5ᵗʰ week. Additionally, in the current study, it was able to measure the fetal BPD after day 40 until day 100 of gestation that were 10.8 and 44.8 mm, respectively (Fig. 5-9) and (Table, 2). These data were in agreement with (23 and 27) who reported that BPD could be measured from 63-130 day and 40-109 day of gestation, respectively, by using trans-abdominal ultrasound examination with 5MHz sector transducer in both previous studies.

Figure, 5: Measurement of BPD in 6ᵗʰ week of pregnancy, indicated by straight line (Sector probe, 5MHz).

Figure, 6: Measurement of BPD in 8ᵗʰ week of pregnancy, indicated by straight line (Sector probe, 3.5MHz).
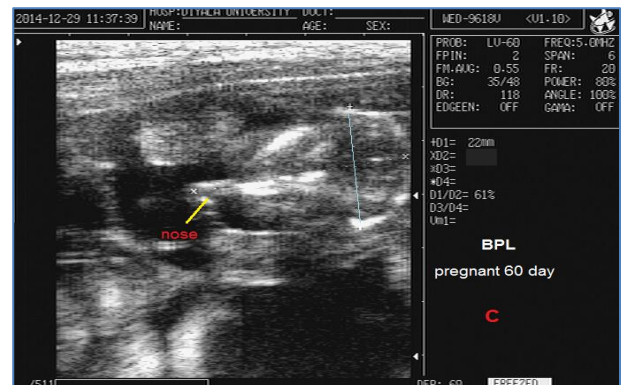
Figure, 7: Measurement of fetal BPD in 9ᵗʰ week of pregnancy, indicated by straight line (Linear probe, 5MHz).

Figure, 8: Measurement of fetal BPD in 11th week of pregnancy, indicated by straight line (Sector probe, 3.5MHz).
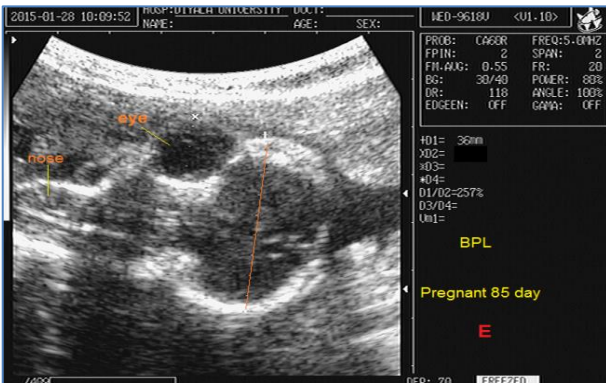

Figure, 9: Measurement of fetal BPD in 12th week of pregnancy, indicated by straight line (Sector probe, 5MHz).

Table, 2: Relationship between gestation age and BPD.

Duration of pregnancy/ week	Bi-parietal Diameter/ Mm
6	10.8
7	15.4
8	17.8
9	21.5
10	29.5
11	30.3
12	34.8
13	36.5
14	44.8
LSD value	9.762 **
** (P<0.01)	

In the meantime, (28 and 29) observed that the BPD measured during 27-106 day and 36-91 day of pregnancy, respectively. This variation as possible might be due to using a different ultrasound machine and performing ultrasonic scanning with trans-rectal approach using 7.5MHz linear probe in previous studies. Furthermore the dissimilarity could be attributed to species of animal; environmental conditions were employed in current and previous studies (20). On the other hand, the result of present study revealed that a strong

positive correlation of coefficient (R^2) between ultrasonic measurement and gestational age were 0.99 and 0.95 for CRL and BPD respectively. The linear measurement and their coefficient correlation were displayed in (Table, 3) and (Fig. 10 and 11).

Table, 3: Correlation coefficient between gestation age with CRL and BPD.

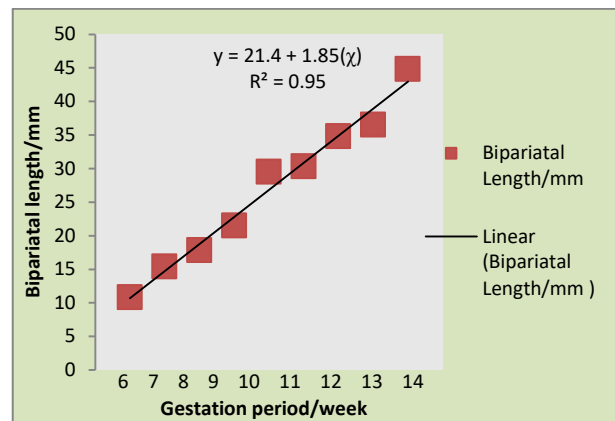| Variable correlated	Correlation coefficient	P-value
Duration of pregnancy and CRL	0.99 **	0.0001
Duration of pregnancy and BPD	0.95 **	0.0042
** (P<0.01)		

Figure, 10: Relationship between BPD (mm) and gestation age (week).
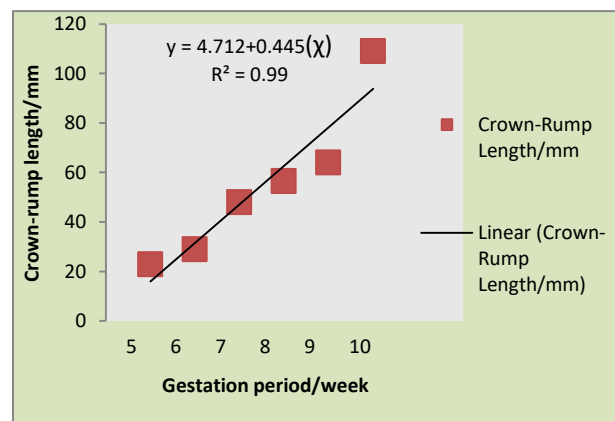

Figure, 11: Relationship between CRL (mm) and gestation age (week).

Similar observations were also found in goats (30) and in sheep (29 and 31) who founded a high correlation ($r^2=0.98$; $r^2=0.98$ and $r^2=0.977$, respectively) between CRL and gestational age during first and second trimester. Other studies performed in sheep

(24 and 26) showed a lower correlation (r^2=0.87; r^2=0.73), respectively; during first trimester of pregnancy as compared to the present data, these differences might be attributed to different species and could be probably be due to the ultrasonic scanning as being limited in the first trimester as compared to the current study which extended ultrasonographic examination to the second trimester.

Additionally, (29 and 32) found a high correlation (r^2=0.93 during 40-100day and r^2=0.98 during 40-120day), respectively, between BPD and gestation period. This corroborates the findings of present result. Authors (33) reported that the ultrasonic fetal head measurement in sheep at earlier stages of pregnancy is comparable to fetal goat. In contrast (18) mentioned that BPD had lower coefficient correlation with gestation period (r^2=0.80); this observation disagrees with the result of present study; it might be attributed to the interval of ultrasonic scanning term in previous study was longer than that of current study as well as the different breed could also be a factor. Also (32) observed that the BPD of the skull was positive when correlated with fetal age and it was concluded that these fetal measurements could be used to predict the age of pregnancy; there results were in agreement with current data.

In conclusions, trans-abdominal ultrasono - graphic approach in goats was a reliable method to the measurement of fetal CRL and BPD during first and second trimesters of gestation and useful for estimate of gestational age as well as prediction of parturition date.

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تقدير مدة حمل الماعز باستعمال تقنية الموجات فوت الصوتية لقياس الطول التاجي وقطر العظم الجداري المزدوج للجنين

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الخلاصة

هدفت الدراسةُ الحالية إلى تقدير مدة الحمل في الماعز بقياس بعض أجزاء الجنين وشملت هذة الأجزاء الطول التاجي وقطر العظم الجداري المزدوج باستعمال تقنية الموجات فوت الصوتية عن طريق الفحص عبر البطن مع مجس منحني ذو تردد ٣,٥ ـ٥ ميغاهرتز. أجريت الدراسة في كلية الطب البيطري، جامعة ديالى، وشملت الدراسة على اثني عشرة معزة متعددة الولادات تراوحت أعمارهن بين ٢ـ٥ سنوات. حقنت جميع حيوانات الدراسة بهرمون البروستوكلاندين ف ٢ الفا (الاستروميت) وبفاصل ١١ يوم بين الجرعتين، لتوحيد الشبق وتحديد مدة الحمل، حيث اعتبر يوم التسفيد هو يوم الصفر. أجري الفحص بالموجات فوت الصوتية أسبوعياً بدءاً من الاسبوع (٥-١٠) ومن الاسبوع (٦-١٤)، لقياس الطول التاجي وقُطر العظم الجداري المزدوج، على التوالي. أظهرت النتائج وبوضوح وجود فارق أحصائي عالٍ عند (P<0.01) بين فترة الحمل وكلاً من الطول التاجي وقطرالعظم الجداري المزدوج. كما بينت نتائج الدراسة الحالية وجود أرتباط موجب عالٍ مع فترة الحمل حيث بلغ (٠,٩٩) و (٠,٩٥) لكلاً من الطول التاجي وقطر العظم الجداري المزدوج، على التوالي. أستنتج من هذه الدراسة الحالية أنه من الممكن تحديد فترة الحمل في الماعز وبدقة عالية عن طريق الفحص عبر البطن باستعمال الموجات فوت الصوتية عند قياس الطول التاجي وقطر العظم الجداري المزدوج خلال الثلث الاول والثاني للحمل.

الكلمات المفتاحية: الموجات فوت الصوتية، الحمل، الطول التاجي، قطر العظم الجداري المزدوج.