ACCURACY OF TRANSRECTAL ULTRASONOGRAPHY: IN ESTIMATING THE GESTATIONAL AGE OF JAMNAPARI GOATS

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ABSTRACT

The precise identification of early pregnancy in farm animals especially small ruminants, plays a significant role in the effective reproductive management of the herd. Early pregnancy diagnosis and foetal measurements of Jamnapari does were carried out using a transrectal probe of B-mode real-time ultrasonography, on a weekly basis starting from day 28 to 100 of gestation age. All the scanning results were recorded. The sensitivity (Se) was 60-95% and specificity (Sp) 50-75% at day 56 respectively. However, the relationship between the ultrasonic foetal parameters and gestational age were highly ($P<0.01$) correlated, although biparietal diameter BPD (0.980) was strongly correlated to gestation age than crown-rump length (CRL) (0.969). In conclusion, the ultrasound early pregnancy diagnosis can be considered a reliable and convenient means for early pregnancy detection. The measurements of CRL and BPD were proven to be an efficient parameters for predicting gestational age in Jamnapari goats.

Key words: Crown rump, Biparietal, Gestation age and Jamnapari goats

INTRODUCTION

The identification of early pregnancy in farm animal especially small ruminants, plays a significant role on its reproductive efficiency. Detection of early pregnancy offers a chance for the breeder to provide maximum care to the goats. Due to early detection of non-pregnant doe the artificial insemination interval decrease by providing the opportunity to rebreed the non-pregnant goats or take alternative measures to avoid economic losses. Although the pregnancy status can be determined by physical examination and laboratory evaluations of the foetus, ultrasound scanning has additional advantage in terms of accuracy; foetal number (Gonzalez *et al*., 2004), sex and even age of the foetal before parturition (Reichle and Haibel, 1991) could be determined. The body length of foetus has been successfully used for long in estimating the foetal age (Mufti *et al*., 2000), and the diameters of the placentomes aid in determining the foetal number (Kasikci *et al*., 2011).

There is no published information that evaluates the accuracy of transrectal ultrasonography and foetal measurements (CRL and BPD) in Jamnapari goats in Malaysia. Thus, the objectives of the present study were to (i) evaluate the accuracy of transrectal ultrasonography for early pregnancy diagnosis, (ii) determine the relationship between the gestational age and foetal parameters such as crown-rump length (CRL) and biparietal diameter (BPD), and (iii) to estimate the gestational age of Jamnapari goats using the B-mode ultrasound scanning machine.

MATERIALS AND METHODS

The study was conducted at Veterinary Research Academy, Department of Veterinary Services' Farms Jenang Marang, Terengganu. All experimental procedures in this trial were performed in accordance

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to the Universiti Sultan Zainal Abidin Animal Ethics Committee (UniSZA/AEC/14/009), Terengganu, Malaysia. The data were obtained from 2-3 year old Jamnapari pure breed does (n=24) weighing between 26-42 kg. The does were artificially inseminated twice with cryopreserved Saanen semen following oestrus synchronisation with CIDR for 12 days and careful observation of the oestrus response. The day of insemination was recorded as day 0 of gestation.

Ultrasound scanning and early pregnancy detection

All the pregnancy detection procedures and foetal measurements were carried out using the transrectal probe, B-mode real-time ultrasound scanner (Draminski® Animal Profi) set at 3MHz. Prior to transrectal scanning, the rectum of each goat was subjected to inspection to ascertain no traces of faeces were to be found during the procedure. Virtually all goats defecated when a finger was inserted into its rectum during the inspection. The probe lubricated with KY Jelly, was pushed gently into the rectum and rotated intermittently in opposite directions at 90% until the image of the bladder was observed on the screen. The uterine horns were found beyond it (the bladder) and, the embryonic fluid or foetal mass is detected in occurrence of pregnancy. The procedure was repeated on a weekly basis; day 28 until day 56 and day 100 of gestation for foetal measurements and early pregnancy detection respectively. All the scanning results were recorded for accuracy evaluation.

Measurement of Crown-rump length (CRL) and Bi-parietal diameter (BPD)

The measurement of the CRL was carried out on a weekly basis, from day 37 to day 72 of gestation. The criteria of the measurement were the greatest length from the upper part of the crown (a) to the end of the rump (b) of the embryonic or foetal mass prior to differentiation of the other body parts and BPD is the maximum diameter (c to d) of the width (Fig. 1) (Karen *et al.,* 2009). The three best features of the foetus scanned were recorded in each week were selected for measurement. The weekly measurement of BPD commenced from day 37 until day 100 of gestation. The procedure was the oval shaped of the head as possible and obtained the diameter from the midline hence dividing the hemisphere into two equal parts (Fig. 1).

Data analysis

The accuracy of the ultrasound pregnancy diagnosis at each particular stages of gestation were determined as the correct pregnant does recorded as correct positive pregnancy (CPP), incorrect pregnant does recorded as incorrect positive pregnancy (IPP), correct non pregnant does recorded as correct negative pregnancy (CNP) and incorrect non pregnant does recorded incorrect negative pregnancy (INP). These will help to determine the sensitivity, specificity and the accuracy of the test at each level of the gestation age (Martin *et al*., 1987) (Table 1).
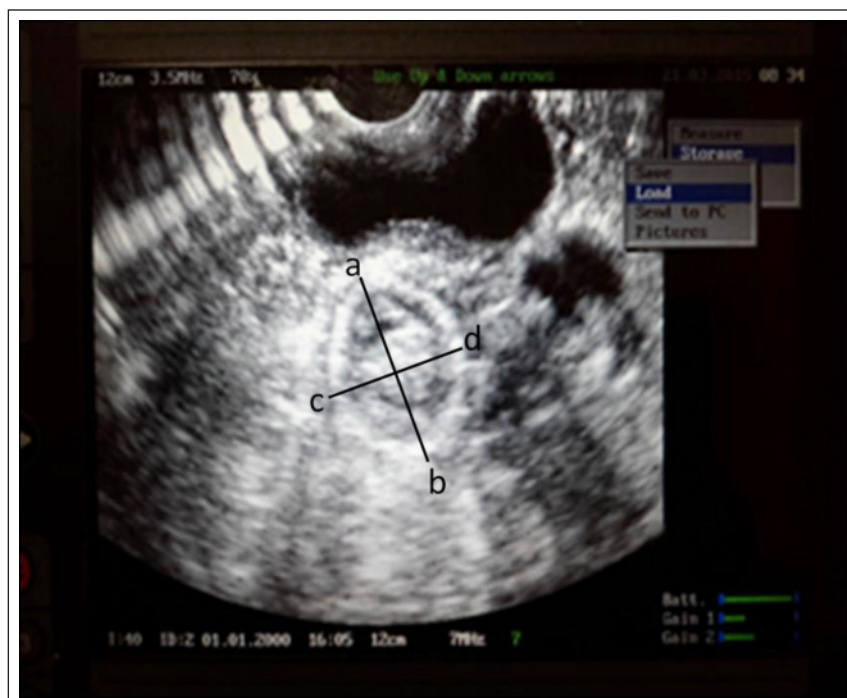

Fig. 1. Measurements of crown-rump length (a to b) and biparietal diameter (c to d).

Table 1. The sensitivity, specificity and predictive measures used for early pregnancy analysis

Early pregnancy parameters	Representation	Formulas
Correct positive pregnancy	CPP	
Incorrect positive pregnancy	IPP	
Correct negative pregnancy	CNP	
Incorrect negative pregnancy	INP	
Sensitivity	Se	$Se = [a/(a + d) \times 100]$
Specificity	Sp	$Sp = [c/(c + b) \times 100]$
Positive predictive value	PPV	$PPV = [a/(a + b) \times 100]$
Negative predictive value	NPV	$NPV = [c/(c + d) \times 100]$
Overall accuracy	OA	$OA = [a + c/(a + b + c + d) \times 100]$

(Martin *et al.*, 1987).

The gestational age relationship with ultrasonic parameters (CRL and BPD) was plotted as linear regression and expressed as quadratic line equations, the gestation age (days) was the independent (Y) and the foetal parameter (CRL or BPD) being the dependent variable (X), a 5% level of significant was used. Regression equations and correlation were established using Statistical Packages for Social Sciences (SPSS) version 20.

RESULTS

The CPP increase from 12 to 20 does at 20-56 days, the IPP was recorded in only two does at 28 day and finally decrease to one, the CNP recorded two does at 28 day which increase to three at 56 day and the INP was eight at 28 day which decrease to one at 56 day of gestation. The sensitivity (Se) increase from 60-95%, specificity (Sp) from 50-75%, the PPV from 85-95%, the NPV from 20-75% and the OA from 58.3- 91.7% at day 28-56 respectively (Table 2). The relationship between foetal parameters and gestational age were highly ($P<0.01$) correlated (Table 3), the regression equation of CRL was $y = 18.776 + 0.606x$ and BPD $y = 19.638 + 2.1x$, although BPD (0.980) was strongly correlated than CRL (0.969) with the gestational age (Fig. 2 & 3).

DISCUSSION

The use of transrectal ultrasonography may be convenient and time saving for early pregnancy diagnosis. The Se (60 and 70%) obtained in the present study at 28 and 35 days were lower than the 75.5 and 84.9% reported by Karen *et al.* (2014) at 24-29 and 31-36 days after breeding. The differences might be attributed to the varying criteria used for the pregnancy diagnosis and breeds used.

The current study used detection of embryonic fluid or foetal mass as the criteria for recording the positive diagnosis while in the other study (Karen *et al.*, 2014) detection of allantoic fluid and/or embryo with a beating heart. Conversely, the Se in this study (60%) at day 28 was much higher than the (28.6%) obtained by Gonzalez *et al.* (2004) at days 20-22. This might be due to the slight increase of the gestational age and procedure used in determining the positive pregnancy. The subsequent increase of the Se (60-95%) from days 28 up to days 56 of gestation in this study, was higher than the (28.6%) reported by Gonzalez *et al.* (2004), the increase may be due to the foetal development and embryonic fluid increase that makes the ultrasonography becomes more visible with increase in the gestational age (Kähn, 1994). The Sp (50-75%) obtained in the current study was relatively lower than (68.3-81%) mentioned in other studies (Lavoir and Taverne, 1989; Gonzalez *et al.*, 2004; Karen *et al.*, 2014). The differences between the Sp of ultrasonography observed in the present study, and other three studies might be attributed to the frequently scanning of five days interval compared to seven days in the present study, frequency of the ultrasound scanning of the Jamnapari does or undetected abortion. The incorrect positive diagnosis made in the study might occured as a result of pathological conditions or estrual fluid that may resemble the appearance of the amniotic fluid (Karen *et al.,* 2014).

Crown rump length (CRL) was one of the parameters used in estimating the gestational age of ruminants and other mammal species (Karen *et al.*, 2009). The recorded CRL in the present study was strongly correlated (0.969) (Fig. 2) with the gestational age from 37-65 days. The result is in agreement with the findings of Karen *et al.* (2009) that range from 25-70 days of gestation, Martinez *et al.* (1998) from 19-40 days of gestation and

Table 2. The sensitivity, specificity and predictive values of transrectal ultrasonography for early pregnancy diagnosis of Jamnapari goats between days 28 - 56 of gestation

Evaluations (n=24)	Days 28	Days 35	Days 42	Days 49	Days 56
CPP	12	14	17	18	19
IPP	2	2	1	1	1
CNP	2	2	2	2	3
INP	8	6	4	3	1
Se (%)	60.0	70.0	81.0	85.7	95.0
Sp (%)	50.0	50.0	66.7	66.7	75.0
PPV (%)	85.7	87.5	94.4	94.7	95.0
NPV (%)	20.0	25.0	33.3	40.0	75.0
OA (%)	58.3	66.7	79.2	83.3	91.7

CPP: correct positive pregnancy, IPP: incorrect positive pregnancy, CNP: correct negative pregnancy, INP: incorrect negative pregnancy, Se: sensitivity, Sp: specificity, PPV: positive predictive value, NPV: negative predictive value, OA: overall accuracy.

Table 3. Regression between gestational age and ultrasonography measurements of crown-rump length (CRL) and Biparietal diameter (BPD) in Jamnapari goats

Measurements	Equations	R^2 (%)	R	P value
CRL**	y = 18.776 + 0.606x	96.9	0.980*	0.001
BPD***	y = 19.638 + 2.1x	98.0	0.989*	0.001

*Pearson correlation, **CRL = crown-rump length, ***BPD = Biparietal diameter, y = gestation age, x = CRL and BPD foetal parameters.
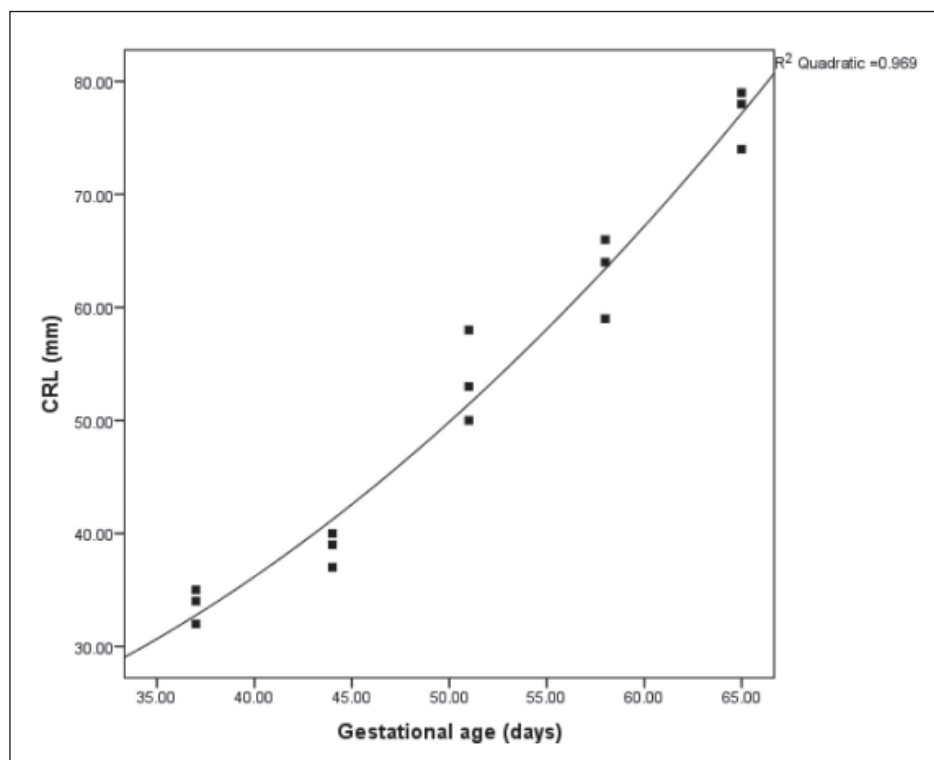
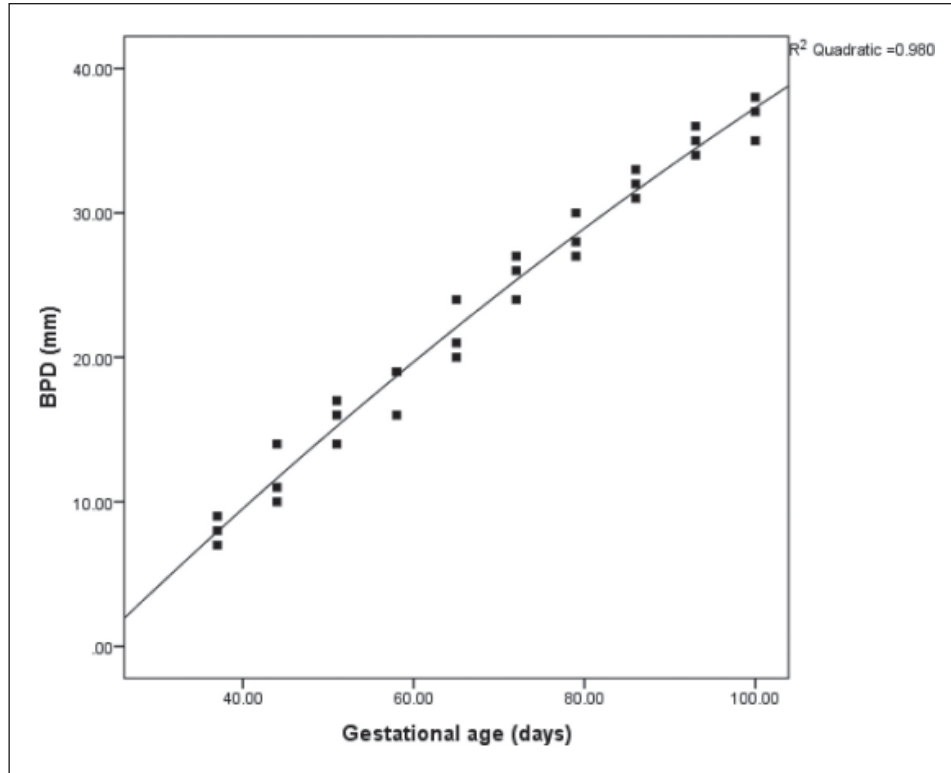**Fig. 2.** Relationship between gestational age and crown-rump length (CRL).

Fig. 3. Relationship between gestational age and Biparietal diameter (BPD).

Abdelghafar *et al*. (2011) between the 35-70th days of gestation. The ultrasonic measurement of the CRL was terminated at 65 days due to the limited viewing field on the scanner when the length of the foetus exceeded the limit of the monitor as a result of the foetus development over gestational period which might lead to inaccurate measurement of the CRL. The regression equation y = 18.776 + 0.606x could be used in predicting the gestational age of a Jamnapari goat.

The BPD measured in the present study was strongly correlated (0.980) (Fig. 3) with the gestational age. The results recorded were in agreement with the findings of Karen *et al*. (2009) at the interval of 30-105 days of gestation. Although lower correlation of determination was reported in the study of Lee *et al*. (2005) between days 60-100 in a Korean black goats. The differences observed between the studies may be as a result of the breeds used and early start of the measurement in relation to the gestational age used (37-100) in the present study which was contrarily to that of the other study (60-100). As mentioned by the Amer (2010) the difficulty observed in measuring BPD after 109 days of gestation is been attributed to the increase in foetal size and compression of the foetal parts and head. Similarly, the BPD of the present study can

be used in the estimation of the gestational age by using the regression equation for y = 19.638 + 2.1x.

CONCLUSION

In conclusion, the transrectal real-time ultrasound scanner can be considered a reliable and convenient tool for the early pregnancy detection in Jamnapari goat (from day 28-100). Moreover, the CRL and BPD ultrasound measurements were proven to be an efficient parameters for gestational age prediction in Jamnapari goats. However, further research is needed to determine the efficiency of transabdominal ultrasonography usage in association to gestational age and also relative to other foetal parameters such as umblical cord diameter, foetal trunk diameter, placentome diameter, foetal heart rate and femur length in Jamnapari goat.

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