Accuracy of Ultrasonography in Early Pregnancy Diagnosis in Doe

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ABSTRACT : The present study was undertaken to evaluate the accuracy of ultrasonography in early pregnancy diagnosis in goats. Ultrasonographic scanning with real time B-mode ultrasound machine having 5 MHz linear array transducer was performed on gravid uterus (n=24) obtained from slaughterhouse (Group I). Crown rump length (CRL) measured by ultrasound was found significantly different ($p<0.05$) with actual CRL measured after dissection in early pregnancy. However, age predicted by ultrasound through the measurement of CRL was found highly correlated (r=0.92) with age measured after dissection through CRL and the weight of fetus. Ages predicted by ultrasound through the measurement of trunk diameter (TD) and uterine diameter (UD) and ages measured after dissection were found highly and equally correlated (r=0.98) and did not differ significantly. Data from six does synchronized (Group II) with PGF2α (Estrumate) at 11 days apart were collected through ultrasound from 17 to 42 days post breding. The correlation between CRL and gestational age was high (r=0.97) in day 30 to 42 post breeding. A high coefficient of correlation (r=0.98) was also observed between predicated age by ultrasound and actual age calculated after kidding. The correlation between CRL and gestational age by the formula Y=(a+bX) i.e. Y=24.42+0.39 X where Y=gestational age and X=CRL, was recorded very high (r=0.99). Accuracy of ultrasonography was lowest on day 17 to 19 (66%) and reached 100% on day 34. Data from 30 does (group III) randomly subjected to only one time ultrasounds scanning to assess the accuracy of pregnancy diagnosis were also obtained. Ages predicted by TD and UD measurements were observed to be non-significantly different with actual age obtained after kidding and correlation between ages predicted by TD and UD measurement with actual age after kidding was found equally and highly correlated (r=0.98). The operator's accuracy in the whole experiment including all three groups was found to be 92%. The sensitivity was 93% and specificity was 86%. From the present study, it was observed that CRL was the most reliable parameter to find out gestational age in early pregnancy and the new formula derived was found very accurate to find out gestational age. TD and UD were also found to be equally reliable parameter to find out gestational age in mid and late stage of pregnancy through ultrasonography. It was concluded that ultrasonography by real time B mode with 5 MHz transrectal transducer was found to be reliable, safe and accurate and practicable means in diagnosing early pregnancy diagnosis as early as 25 days post breeding. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 6 : 760-768)***

Key Words : Crown Rump Length, Doe, Early Pregnancy, Trunk Diameter, Uterine Diameter and Ultrasonography

INTRODUCTION

Early pregnancy diagnosis in goats is needed as it aids in culling or rebreeding of barren does with minimum necessary delay. It also provides a valuable tool in selection of animals for increased fecundity and culling of non-productive animals. Economic losses in milk and kid production can be minimized or avoided through early diagnosis of pregnancy in goats. Early pregnancy diagnosis and determination of fetal numbers will also help in proper planning of managemental practices and the nutritional plane to be adopted in relation to the nutrient requirement for proper fetal growth in addition to maternal requirement according to the stage of pregnancy and fetal numbers. It will also reduce the mortality by lessening the incidence of metabolic diseases like pregnancy toxemia (Ford, 1983) and to minimize pre kidding feeding cost. In addition, the accurate information on the stage of gestation would be useful to dry off lactating females at adequate period and to monitor females near term (Doize et al., 1997).

Some of the methods that have been described to diagnosis pregnancy in goats and ewes over the last few decades include radiography, estrone sulphate (Refstal et al., 1991), progesterone essay (Murray and Newstead, 1988), vaginal biopsy (Richardson, 1972), palpation of uterus via laparotomy (Smith, 1980), pregnancy specific antigen (Humblot et al., 1990). The application of these methods on a large scale in veterinary practice has remained limited because of lack of practicality or the methods are insufficiently inaccurate.

For the last three decades, ultrasound systems have been used in small ruminants to diagnose pregnancy: the Doppler system (Trapp and Slyter, 1983) based on the detection of the fetal circulation or fetal movements and A mode system (Watt et al., 1984) which detects tissue interfaces with different acoustic impedance, which could detect pregnancy accurately during the second half of gestation.

Real time B mode ultrasonography (Davey, 1986; Haibel, 1990) introduced to veterinary practice in early

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eighties offered a new tool for early pregnancy diagnosis. It also offers an accurate, rapid, safe and the practical means of diagnosing the pregnancy, fetal numbers and estimation of gestational age in livestock. False positives are rare. In addition to assess the fetal viability, numbers and age, real time ultrasonography can also be helpful in diagnosing disease of reproductive tract (Buckrell, 1988). But a method of choice for diagnosing pregnancy in a small ruminants depend on the availability of equipments, cost, number of days post breeding, desired accuracy and the experience of the examiner.

The present investigation has been carried out taking into consideration of ultrasonography as a useful tool for early pregnancy diagnosis in does with the following objectives.

1. To determine the ability to distinguish between pregnant and non-pregnant does.
2. To determine the age of foetus using different parameters (CRL, TD, UD, actual CRL and weights).
3. To determine the accuracy of early pregnancy diagnosis on the basis of ultrasonography.

MATERIALS AND METHODS

The present study was carried out in graded Jamunapari goats available in the goat unit of Department of Livestock Production and Management, College of Veterinary Science and A. H. Anjora, Durg (Chhattisgarh), India. For the studies, 36 numbers of nulliparous and multiparous does between 1.5 to 6 years of age, weighing 25 to 40 kg were selected. The does were housed in the appropriate shed and they were allowed to graze for 6 to 8 h daily on good quality pasture and they were fed with extra concentrated mixture having C.P. 16% and TDN 60% as per their requirement with water *ad libitum*. Ultrasound examinations were performed with a real time, B mode diagnostic ultrasound instrument equipped with a linear array 5 MHz transducer designed for transrectal placement (Pie Medical, Philips 200 Vet Scanner, Nether land). The ultrasound transducer was modified by taping a small wooden rod (1.25×38 cm) on the dorsal part of the transducer for control manipulation of the transducer in transrectal scanning in goats. They were restrained lightly in the standing position with the help of an attendant. The rectum was cleared of fecal pellets and the modified transducer was well lubricated with ultrasound jelly (Ultra-gel, Roll Max India, Bhopal) before insertion into the rectum to improve coupling. The transducer was gently passed along the rectal floor to avoid fecal pellets left and to establish good contact between the transducer and the rectal mucosa till the bladder was displayed on the screen. The scanner was placed at eye level near operator and the ambient lighting was made dimmed for better visibility of the image. The distance of penetration of the transducer depended upon the size of the doe examined and the amount of the fluid present in the bladder. The transducer was rotated 45° to 90° clockwise and then 180° counter wise to image the entire reproductive tract and the foetus. The doe was diagnosed pregnant if a discrete, intrauterine, sharply demarcated anechoic, round or oval structure was detected in uterine lumen or if an apparent conceptus (anechoic, elongated structure) or embryo proper were detected in the uterine lumen. Better resolution images were freezed. The whole experiment was divided into three groups.

In group I gravid uteri of slaughtered does (n=24) were brought from slaughterhouse for ultrasound scanning. These organs were kept in water filled tray covering all the organs and ultrasound examination was performed. Comparisons were also made between Crown rump length detected by ultrasound machine and actual crown rump length recorded after dissection.

In group II six numbers of does were synchronized with $PGF_2\alpha$. Estrumate (Cloprostenol, M/s. Essex Tierarznie, Germany) @125 µg/goat intramuscularly 11 days apart. The does were observed for estrus every eight hours from 12 hours onwards after first dose of injection and vasectomised buck was allowed to run with the lot but they are kept safe from the fertile buck. After second dose of injection, same observations was made and fertile bucks were let to mate and date of service was recorded. Ultrasound scanning was performed on each day of 16 to 19 days, 21 to 23 days, 24 to 26 days, 32 to 34 days, onwards upto 42 days based upon the day of detection of estrus and the observed breeding (estrus=Day 0). Age of the foetus and the stage of pregnancy were decided with the help of above parameters and the date of kidding for each doe was predicted. Comparison was made between the predicted value and the actual value recorded after kidding.

Group III was random group comprising of 30 does available in the goat unit. Does were ultrasonographically scanned to determine the pregnant and non-pregnant status.

Statistical analysis

Pregnancy data were analysed by goodness of fit between the predicted age and the actual age as per the methods described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The present investigation was carried out to study the application of ultrasonography in predicting the age of foetus, in distinguishing pregnant and non-pregnant does and its accuracy in pregnancy diagnosis of goats.

Group-I: slaughtered gravid uterus

Accuracy of ultrasonography in predicting CRL and age

Table 1. CRL and age of fetus in comparison to actual CRL and age in early pregnancy

Sample No.	Ultrasound measurement		Actual measurement		
	CRL (mm)	Age (days)	CRL (mm)	Weight (gm)	Age by CRL and weight
1	38.9*	36	30.0	3.8	37
2	29.7*	36	20.5	2.0	31
3	14.0*	28	13.5	0.7	27
4	21.2*	32	19.5	0.8	31
5	58.5*	47	38.0	5.0	46
6	27.6*	35	25.0	3.0	37
7	36.7*	39	33.0	4.50	42

* Differs significantly ($p<0.05$).

Table 2. Comparison of Trunk diameter (TD) and Uterine diameter (UD) in prediction of fetal age by ultrasound with age by actual CRL and weight

Sample No.	Ultrasound measurements				Actual age (days)by CRL and Wt.
	TD (mm)	Age (days)	UD (mm)	Age (days)	
1	41.7	93	74.5	94	93
2	36.7	89	66.0	88	85
3	41.7	95	76.6	94	87
4	59.0	109	>88.3	>103	105
5	36.2	85	62.1	87	79
6	49.8	102	83.0	103	103
7	16.6	57	32.9	56	57
8	21.9	61	45.9	70	67
9	18.2	60	37.1	61	57
10	36.0	90	69.1	91	85
11	47.3	100	84.7	100	95
12	61.0	110	>88.3	>103	108
13	26.9	77	52.9	78	76
14	31.8	84	61.5	85	86
15	45.2	98	79.7	97	96
16	23.7	71	84.8	70	69
17	16.6	57	34.2	58	57

>Readings are beyond the range of ultrasound machine and hence not measurable.

of the fetus and its comparison with actual CRL and age of the fetus in early pregnancy has been observed. In this group actual age means age predicted by CRL measurement and the weight of the fetuses after dissection (Singh et al., 1979). Results pertaining to this group of early pregnancy in gravid uterus obtained from slaughtered house are presented in Table 1. CRL measured by the ultrasound machine and the predicted ages was compared with ages predicted by the actual measurement of CRL and weights of the fetus after dissection. The result revealed that there was no significant difference between ages predicted by ultrasound and the ages measured after dissection. However, CRL measured by ultrasound and the actual CRL measured were found significantly different ($p<0.05$). The CRL measured through ultrasound was found on the higher side than the actual measurements and a correction factor (0.83) for CRL measured through ultrasound is required to find out actual CRL. Similarly, the age predicted by ultrasound was observed to be highly correlated ($r=0.92$) with the age measured after dissection.

The purpose of the study was to obtain this correction factor so that any discrepancy between age predicted by ultrasound and actual age could be minimized. The CRL has been frequently used in postmortem fetal observation in different species and is considered one of the most representative measures in relation to the day of gestation (Evans and Sack, 1973). Ginther and Pierson (1984) used the same technique to compare ultrasound images of ovarian surface and the actual ovarian surface in horse. However, any related reference to the study could not be obtained.

Accuracy of trunk diameter (TD) and uterine diameter (UD) in prediction of fetal age and its comparison with age predicted after actual measurement of CRL and weights of the fetus in mid and late pregnancy have also been performed. Results are presented in Table 2. After 8 weeks of pregnancy, measurements of CRL by ultrasound machine were not possible that's why the measurements of TD of the fetus and UD of the gravid uterus were taken. Ages predicted by TD measurements through ultrasonography were found highly correlated ($r=0.98$) with actual ages measured and the difference was found non-significant. Similarly ages predicted by UD measurement and the actual ages measured were found highly correlated ($r=0.98$) and

Table 3. Accuracy of ultrasonography in prediction of CRL and age and its comparison with actual age after kidding

Observation No.	Goat No.	Ultrasonographic measurements		Actual age after kidding (days)
		CRL (mm)	Age (days)	
1	001	20.2	31	32
2	95,667	20.5	31	32
3	12,602	21.1	32	32
4	74,912	16.6	30	32
5	002	22.8	32	32
6	001	25.7	34	34
7	95,667	24.3	33	34
8	12,602	25.3	34	34
9	74,912	23.4	33	34
10	002	26.5	34	34
11	001	31.8	36	36
12	95,667	27.4	35	36
13	12,602	30.4	36	36
14	74,912	27.2	35	36
15	002	31.2	36	36
16	001	36.4	38	38
17	95,667	33.0	37	38
18	12,602	36.5	38	38
19	74,912	36.0	38	38
20	002	35.5	38	38
21	001	39.7	40	40
22	95,667	39.5	40	40
23	12,602	36.7	39	40
24	74,912	39.0	39	40
25	002	38.1	39	40
26	001	46.1	42	42
27	95,667	41.2	41	42
28	12,602	46.2	42	42
29	74,912	43.0	41	42
30	002	46.1	42	42

observed non-significant difference between two ages. Ages predicted by TD measurement and UD measurement were highly and the equally correlated actual age.

The present study observed TD of 4.73 cm in around 100 days of fetal age, which increased to 6.10 cm at 110 days of fetal age. Aiumlamai et al. (1992) reported TD of 5.8±0.60 cm around 100 days of fetal age in sheep, which increase to 8.28±0.66 cm at one week before lambing. There are two common parameters (TD and UD) available for prediction of fetal age after 8 weeks of age through ultrasonography. The present study revealed that TD and UD measurement were highly and equally correlated (r=0.98) with actual age. Kahn et al. (1995) also reported similar finding of high correlation between TD and fetal age. So, both parameters can be used successfully in prediction of fetal age.

Group-II: synchronized goats

Time interval between PGF2α and onset of estrus was observed between 39 h to 88 h on an average of 47.83±19.69 h.

Gonzalez et al. (1984). Wani et al. (1985). Na et al. (1987) and Rainio (1992) also reported slightly more or similar findings. However, Ishwar and Pandey (1990), Phalak et al. (2000) and Gade and Takarkhede (2001) reported longer time interval (more than 60 h) than the present study. Perrera et al. (1978) on the contrary reported shorter time interval of 20.4±0.9 h. These differences may be due to breed difference, geographical changes, location changes and changes in batch of the hormone and salt of the hormone.

Accuracy of CRL in early pregnancy diagnosis was recorded. During the first 20 days following estrus, the uterus was situated in close proximity to the transducer (4 to 6 inches) in to the rectum within the pelvic cavity. The body of the uterus was centered over the urinary bladder and each horn is deviated ventro-laterally to its respective site. Circular and elongated hypo-echoic structure (about 4 mm in size) was observed during the first 17 to 19 days; however, it was difficult to distinguish between apparently free intra-uterine luminal fluid and the presence of an elongated trophoblast. Ultrasonographic images of uterus in pregnant does on day 21 to 42 displayed prominent circular folds and hypo-echoic chambers cranio-ventral to the bladder. Embryos were visualized as echogenic structures with in the chorio allontoic sac. On day 17 to 19 of gestation, three does were diagnosed pregnant with apparent visible of embryonic vesicle. On day 21 to 23, five does were diagnosed as pregnant. But on day 25, two does were confirmed as pregnant with detection of proper embryo. On day 26, proper embryo could be detected in five does and in the sixth doe, embryonic vesicle was apparently visible on day 26 in form of a circular hypo-echoic structure but proper embryo in this doe was not detectable even on day 29 and onwards. Thus, it was confirmed as non-pregnant. The measured CRL on days 30, 32, 34, 36, 38, 40 and 42 were 17.5±0.13, 21.9±0.12, 25.9±0.08, 31.1±0.07, 34.9±0.21, 38.9±0.11 and 46.1±0.007 mm, respectively (Table 3). A linear increase in CRL was observed with gestational age.

A high coefficient of correlation (r=0.98) was observed between the predicted age and the actual age. All the five goats diagnosed as pregnant kidded with an average gestation period of 150.2±2.68 days, with a range of 146 to 153.

In the present study at least three embryonic vesicles in three goats out of six were visible on day 17 to 19 and five embryonic vesicles in five goats could be visible on day 21 to 23. Findings of the present study are similar and in agreement with Garcia et al. (1993) and Doize et al. (1997) in ewe. Martinez et al. (1998) also observed a non-ecogenic area in the uterus of doe only after 18 days of post breeding. However, Gonzalez et al. (1998) and Kareni et al. (2001)

reported the identification of embryonic vesicle as early as in day 12 post mating using 7.5 MHz probe in ewe. Since ultrasound examination was undertaken in this group from day 17 post breeding onwards, the visualization of embryonic vesicles could not be established before day 17. The first ultrasonographic signs of a possibly pregnant uterus are the visualization of fluid filled uterine sections (anechoic) before day 20 (Buckrell, 1988). However, the confirmatory sign of pregnancy is the detection of proper embryo (Martinez et al., 1998). In the present study, embryo proper was detected in two does on day 25 and in five does on day 26. Embryo proper has frequently been visible on day 25 (Schrick and Inskeep, 1993) and on 24 to 26 days (Kaulfuss et al., 1999). Garcia et al. (1993) also reported ultrasonographic appearance on day 21 to 34 post breeding in ewe. However, Gonzalez et al. (1998) and Martinez et al. (1998) reported visualization of embryo as early as on day 19 of gestation. Jitendra Kumar (2000) reported the visualization of conceptus at the beginning of 4 weeks post breeding. The present study could not record the heartbeat due to problems related to power source and frequent movement of does and poor image quality and poor resolution of the probe. The same problems were also encountered by (Gonzalez et al., 1998; Martinez et al., 1998).

The measured CRL of embryo on day 30, 34, 36, 38, 40 and 42 were recorded as 17.5±0.13, 25.9±0.08, 31.1±0.07, 34.9±0.21, 38.9±0.4 and the 46.1±0.007 mm, respectively. Schrick and Inskeep (1993) had more or less similar findings of CRL as 17.0±2.0, 25.0±2.0 and 36.0±4.0 mm on day 30, 35 and 40, respectively. Shin et al. (2001) reported lower values of CRL on day 30, 35 and 42 as 11.26±4.08, 16.51±3.71 and 27.60±5.3 mm, respectively than the present findings. Martinez et al. (1998) also reported lower value of CRL on day 40 as 34.2±0.6 mm. The difference in these values of CRL might be due to difference in breed, nutrition and other factors.

In the present study a high (r=0.97) correlation between CRL and the gestational age was observed. Similar observation (r=0.98) was also reported by Kahn et al. (1995). However, lower correlation (r=0.92 and 0.94) between the two parameters was reported by Gonzalez et al. (1998) and Martinez et al. (1998), respectively.

Relationship between CRL and gestational age was also calculated. Crown rump length (CRL) of the caprine fetus was recorded from day 30 to 42 days of gestation and described the relationship between CRL (X) and the gestation age (Y) by the equation $Y=14.05+1.16\ X-0.012\ X^2$ (Schrick and Inskeep, 1993). The correlation between CRL and gestational age was high (r=0.97) in days 30 to 42. The correlation between actual age and the age by formula was observed to be (r=0.94) and between CRL and age by ultrasound was high (r=0.99). The correlation between CRL and gestational age by new formula adopted. Y=(a+bX) i.e. Y=24.42+0.39X was recorded very high (r=0.99). The correlation of coefficient between CRL measurement and the gestational age by the newly derived formula i.e. Y=a+bX (Y=24.42+0.39X) where Y=gestational age and X=CRL in mm, was observed to be very high (r=0.99). Therefore the new formula is more accurate in prediction of gestational age in comparison to the formula given by Schrick and Inskeep (1993).

Accuracy of ultrasonography in diagnosis of early pregnancy and non-pregnancy was determined after comparing with actual kidding. The percentage of does accurately diagnosed was lowest (66%; 4/6) on day 17 to 19, on day 21 to 23, it reached 83% (5/6) and on day 24 to 26, all six does were accurately diagnosed (100%, 6/6). On day 32 to 34 five does were confirmed as pregnant and one doe was diagnosed as non-pregnant. The sensitivity increased from 60% on day 17 to 19, to 80% on day 21 to 23, reached 100% on day 24 to 26 and the same value was recorded on day 32 to 34. Similarly, the specificity also increased from 33% on day 17 to 19, to 50% on day 21 to 23 and reached 100% on day 24 to 26 and day 32 to 34.

All the five does confirmed as pregnant on day 30 kidded in between 146 to 153 days from the day of estrus with an average gestation of 150.2±2.68 days. The findings are in agreement with the earlier reports of Fakruddin (1996) and Jainudeen et al. (2000). However, Roy (1991) reported that the gestation period of 147 days in Jamunapari goats. Biswas and Koul (1994) and Mia et al. (1996) reported average gestation period of most of the Indian breeds of goats ranged from 145 to 151. A slight difference in the gestation period might be due to various factors like age of the dam, nutrition and the environmental factors.

The percentage of does correctly diagnosed was lowest 66.66 on day 17 to 19 and reach 100% on day 32 to 34 with sensitivity and specificity of 100%. The percentage of accuracy, sensitivity and specificity values obtained in the study were comparable to the results obtained in the earlier report of Garcia et al. (1993) in which ultrasound examination was performed on day 17 to 34 post breeding in ewe. However, the sensitivity value was reported lower than that of the present study. Johns (2002) had also similar report of 100% accuracy in diagnosing pregnancy in ewe by day 40 post breeding with real time ultrasound machine and Buckrell (1998) also reported that the accuracy could exceed 95% as early as day 25 post breeding using transrectal technique, which is in agreement with the present finding.

Group-III: random group

Accuracy of TD and UD in prediction of fetal age through ultrasonography and its comparison with actual age after kidding was performed by only one time scanning for

Table 4. Accuracy of TD and UD in prediction of fetal age and its comparison with actual age after kidding through ultrasonography

S. No.	Stage of pregnancy	Parameters				Actual age on day of scanning*
		TD (mm)	Age (days)	UD (mm)	Age (days)	
1	Early	15.2	53	32.0	55	50
2	Early	15.6	54	31.5	54	54
3	Early	15.9	55	30.7	54	56
4	Mid	32.8	85	70.0	91	86
5	Mid	20.0	64	38.3	63	59
6	Mid	23.0	70	45.5	71	65
7	Mid	39.9	93	73.1	93	92
8	Mid	31.5	83	57.6	82	80
9	Mid	19.8	64	38.1	63	60
10	Mid	43.8	97	78.1	96	95
11	Late	75.2	119	>89.0	>103	120
12	Late	49.8	102	81.2	98	91
13	Late	49.6	101	81.2	98	98
14	Late	49.7	102	81.5	98	101

* Average gestation period is taken as 150 days (Jainudeen et al., 2000). Early pregnancy-up to 8 weeks.
Mid pregnancy-8 to 14 weeks. Late pregnancy-beyond 14 weeks. >Readings are beyond the range of the machine and hence not measurable.

each matured does. Table 4 revealed that there was no significant difference between the age predicted by TD measurements through ultrasound and the actual age after kidding. A high coefficient of correlation (r=0.98) was observed between age by TD and actual age. Similarly, no significant difference between age predicted by UD measurement through ultrasound and actual age was also observed. Age by UD and actual age was found to be highly correlated (r=0.98). Age predicted through ultrasound by TD was found on higher side than actual age in one doe and lower in one doe and equal in another does of the early pregnant. In mid pregnancy the predicted ages by TD were found on higher side than actual ages in six does and it was on lower side in one sample. However, in all the six samples ages predicted by UD measurement were found on higher than actual age. In advanced pregnancy, it was found on higher side in three does in case of ages predicted by TD than actual age and only in one doe, it was observed on lower side. In case of age by UD, it was observed on higher side in two does and in one sample it was on lower side than the actual age. In one case, age could not be predicted through ultrasound, as the measurement beyond 89 mm was not possible.

Similar observations of high correlation between TD and gestational age in ewes were reported in earlier studies (Kahn et al., 1995). The correlation between TD measurement and fetal age (r=0.98) is consistent with that of the prior study in Merino ewes (Sergeev et al., 1990) and Manchega dairy ewes (Gonzalez et al., 1998). Shin et al. (2001) also used same parameter for estimation of fetal age in goats form 6 weeks to 20 weeks of gestation. Although no reference on UD measurement for estimation of caprine fetal age was obtained, the present study revealed that it was also highly correlated with age of the fetus. So UD can also be taken as one of the parameters for estimation of the age of the caprine fetus. However, uterine diameter was used for estimation of gestational age in cattle (White et al., 1985).

Accuracy of ultrasonography in pregnancy diagnosis of does was also performed for this group. Results are depicted in Table 5. In this group, out of 6 does, which were diagnosed as non-pregnant, one doe kidded and the rest have not kidded giving specificity (the ability of diagnosing non-pregnant) to 83.3%. Out of 24 does diagnosed as pregnant, 2 does did not kid and 22 does kidded within 2 to 3 days predicted kidding at the time of scanning. The sensitivity (the ability of diagnosing pregnant) reached to 92%. The pregnancy diagnosis in mid and advanced stage could be certainly confirmed. But in early pregnancy, it could not be correctly diagnosed in two does at days 19 to 23. As it was based on apparent appearance of anechoic (oval or round) in uterine lumen. In this group, only one time scanning was performed for each doe.

Earlier reports of 89.1% accuracy in ewe on day 35 to 46 post breeding (Zipper et al., 1997) and 90% accuracy in sheep and goat on day 40 to 45 post breeding (Goel and Agrawal, 1992) were comparable to the result of the present study. Accuracy of diagnosis in this group was less (7 does kidded out of 9 diagnosed pregnant) in early pregnancy in comparison to mid (7/7) and late pregnancy (8/8). The source of inaccuracy in ultrasonographic diagnosis might be due to transducer resolution, image processing and formation and the biased of the echographist.

Overall accuracy of ultrasonography for pregnancy diagnosis of does in the whole experiment, total of 36 does were scanned through ultrasonography for pregnancy diagnosis. Out of 29 does diagnosed as pregnant, 27 does kidded. At the same time, 7 numbers of does was diagnosed as non-pregnant, out of which 1 doe kidded. The sensitivity of the whole experiment reached 93% and the specificity

Table 5. Accuracy of ultrasound in diagnosis of pregnant and non-pregnant status

S. No.	Reproductive status	Parameters						Results
		CRL (mm)	Age (days)	TD (mm)	Age (days)	UD (mm)	Age (days)	
1	Non	-	-	-	-	-	-	Not kidded
2	Non	-	-	-	-	-	-	Not kidded
3	Non	-	-	-	-	-	-	Not kidded
4	Non	-	-	-	-	-	-	Kidded*
5	Non	-		-	-	-	-	Not kidded
6	Non	-	-	-	-	-	-	Not kidded
7	Early	18.5	30	-	-	-	-	Kidded
8	Early	18.2	30	-	-	-		Kidded
9	Early	11.0	19	-	-	-	-	Not kidded**
10	Early	23.5	33	-	-	-	-	Kidded
11	Early	12.4	23	-	-	-	-	Not kidded**
12	Early	28.2	35	-	-	-	-	Kidded
13	Early	68.0	50	15.2	53	32.0	55	Kidded
14	Early	75.1	53	15.6	54	31.5	54	Kidded
15	Early	76.6	53	15.9	55	30.7	54	Kidded
16	Mid	-	-	32.8	85	70.0	90	Kidded
17	Mid	-	-	20.0	64	38.3	63	Kidded
18	Mid	-	-	23.0	70	45.5	71	Kidded
19	Mid	-	-	39.9	93	73.1	93	Kidded
20	Mid	-	-	31.5	83	57.6	82	Kidded
21	Mid	-	-	19.8	64	38.1	63	Kidded
22	Mid	-	-	43.8	97	78.1	96	Kidded
23	Late	-	-	75.2	119	>89.0	>103	Kidded
24	Late	-	-	49.8	102	81.2	98	Kidded
25	Late	-	-	49.6	101	81.2	98	Kidded
26	Late	-	-	49.7	102	81.5	98	Kidded
27	Late	-	-	>87.9	>125	>89.0	>103	Kidded
28	Late	-	-	>87.9	>125	>89.0	>103	Kidded
29	Late	-	-	>87.9	>125	>89.0	>103	Kidded
30	Late	-	-	>87.9	>125	>89.0	>103	Kidded

* Diagnosed as non -pregnant but kidded. ** Diagnosed as a pregnant but not kidded.
Early pregnancy-up to 8 weeks. Mid pregnancy-8 to 14 weeks. Late pregnancy-beyond 14 weeks.
> Readings are beyond the range of the matching and hence not measurable.

also reached to 86%. The overall accuracy of the same operator was found to be 92%.

More than 95% accuracy of diagnosing pregnant were reported in ewe (Grace et al., 1987; Logue et al., 1987) and accuracy of 100% in diagnosing pregnant status was also reported by White et al. (1984) in ewe between 50 to 100 days of gestation by using real time ultrasonography. By using Doppler system of ultrasonography, Deas (1977) reported the sensitivity and specificity of 82% and 91%, respectively, in ewes from day 41 to 60 post breeding and Lindallhl (1971) also reported accuracy greater than 90% in mid gestation with the same system in ewe. Meredith and Madani (1980) observed an accuracy of 83% of diagnosing pregnancy with 96% sensitivity and 87.5% specificity in ewe between 61 to 151 days of gestation with A mode ultrasonography. Similar report of Madel (1983) with 80.1% diagnostic accuracy of ultrasound with sensitivity 86.7% and the specificity of 69.1% in ewe between day 73 to 103 post breeding and 97% accuracy form day 51 onwards by Watt et al. (1984) with A mode ultrasonography were also observed.

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