Praca oryginalna *Original paper*

Determination of gestational age by measuring fetal heart diameter with transrectal ultrasonograph in sheep

HASAN ORAL, SUKRU METIN PANCARCI, ORSAN GUNGOR, CIHAN KACAR

Department of Obstetrics and Gynaecology, Faculty of Veterinary Medicine, Kafkas University, 36100 Kars, Turkey

Oral H., Pancarcı S. M., Gungor O., Kacar C.
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Summary

The study investigated the efficacy of fetal heart diameter for estimating gestational age by using transrectal ultrasonograph. For this purpose, two experiments (two stages of study) were performed on 36 fat-tailed sheep. In the first experiment, when the pregnancies had been detected 30 days after breeding (day 0), fetal heart, biparietal and trunk diameters were measured at 15-day intervals between days 40 and 100 of pregnancy to compare the estimated and actual gestational ages in 28 ewes. In the second experiment – a blind study – gestational ages were estimated at unknown ages of pregnancy by the operator in 8 ewes. There were positive correlations ($p < 0.01$) between the estimated and actual gestational ages determined by fetal heart, biparietal and body trunk diameters in stage I and stage II of the study, respectively ($r = 0.99$, $r = 0.99$; $r = 0.99$ and $r = 0.89$, $r = 0.91$, $r = 0.97$). In conclusion, transrectal ultrasonographic examination was reliable tool to estimate gestational age between days 40 and 100 of pregnancy, and estimatiing gestational age by fetal heart diameter was as reliable as that estimated by biparietal and trunk diameters.

Keywords: sheep, ultrasonograph, fetal heart diameter, gestational age

Pregnancy diagnosis in ewes is of considerable economic value to sheep farmers. Early diagnosis of pregnancy and the ability to count the number of fetuses are useful for nutritional management and marketing. Feedlot operators would minimise reproductive loses and maximise feed conversion efficiency and economic returns if the pregnancy status and gestational age could be accurately determined. Accurate information on the stage of gestation would also be useful to dry-off lactating females at the appropriate time and to monitor females near term. In addition, the fetal-lamb model is a fundamental tool for developing clinical applications for the treatment of human fetal pathology, for example open fetal surgery. Accurate estimation of gestational age is important to avoid size-related problems during pregnancy (1, 9, 12,16).

Real-time B-mode ultrasonic scanning of the uterus in sheep appears to offer an accurate, rapid, safe and practical means for diagnosing pregnancy, determining fetal numbers and estimating gestational age. Generally, scaners with sector, linear and convex probes at frequencies of 3.5 to 7.5 MHz can be used for transrectal and transabdominal examinations. Linear probes appear beter suited for transrectal examinations, whereas sector probes are preferred for transabdominal examinations (7, 9, 11, 15). It has been stated by researchers that using transrectal ultrasonograph is more useful in determining early stages of pregnancy and especially in determining gestational age (7-9, 11). Measuring the diameters of the embryonic vesicle, biparietal and trunk are the most widespread methods but it is known that biparietal diameter is more reliable for exact determination of gestational age (1, 7). In according to values, although certain determination of pregnancy can be understood from 40-60 days of pregnancy as ultrasonography in small ruminants, it is known that fetal structures are determined as certain only between 40 and 100 days to determine fatel age in the last researchs (2-5, 17). Examinations of fetal heart are a very important criteria in determining fetal viability. It has been reported that fetal heart beats can be determined clearly from the 25^{th} and 30^{th} day in which the fetus can be clearly seen (1, 3, 7, 10, 11). Fetal hearts are clearly seen at days 44 to 63 days of gestation and heart chambers and valves are distinguishable from days 97 to 103 of gestation (1).

The aim of this study was to use real-time ultrasonography to follow the growth of the fetus to estimate gestational age by measuring the fetal heart diameter (FHD), diameter of the body trunk (BD) and biparietal diameter of the skull in ewes. In addition, a formula was developed by measuring fetal heart diameter (FHD) for this purpose can be used in pregnant ewes in this study.

Material and methods

Thirty six fat-tailed ewes, one to four years old, were used. The study was divided into two stages. In the first stage of the study twenty-eight ewe pregnancies were determinated at days 25 and 30 following copulation. Fetal heart diameter (FHD), diameter of the body trunk (BD) and biparietal diameter of the skull (BPD) were measured from days 40 to 100 in 15-day periods. In the second stage of the study eight ewes were examined randomly at any stage of the pregnancy, and copulation dates were unknown by the operator. Fetal heart diameter (FHD), diameter of the body trunk (BD) and biparietal diameter of the skull (BPD) were measured. Gestational age was determined according to Parraguez et al. (14) by measuring the diameter of the body trunk (BD) and biparietal diameter of the skull (BPD). Heartbeat was observed in the thoracal region of fetus. Once the heart was largest in size, the view was frozen and its diameter was measured. Measurements were made from days 40 to 100 of pregnancy and gestational age was estimated using a formula specifically designed for this study. A real-time ultrasound scanner equipped with a 6 MHz linear-array transducer (ESAOTE® 410477, Pie MEDICAL) was used for the study. Ultrasonographic examinations were made transrectally. The transducer was taped to a plastic rod to allow manipulation from the outside after it had been inserted into the rectum. All the ultrasonographic examinations were done by the same operator who had experience in performing ultrasonographic pregnancy diagnosis in small ruminants.

Results and discussion

All the ewes diagnosed as pregnant had only one fetus. In the first stage of the study, a fluid filled uterus fetal heart beat was observed at days 25 to 30 of gestation. Fetal structures and heart were determined clearly at days 40 to 100 of pregnancy, and heart chambers and valves were observed at the 100th day of pregnancy (fig. 2, 3, 4, 5). In both the first and second stage of the study, positive correlations were determined between estimated and actual gestational age. The linear measurements and their regressions coefficients are presented in fig. 1 and tab. 1, 2, with significant correlation coefficients ($p < 0.01$).

Estimated gestational age (day): GA = FHD × 25.9358 + 29.5, FHD = fetal heart diameter (cm), stable number = 25.9358 = GA – 29.5/FHD, day of fetal heart was viewed clearly (average) : 29.5.

The embryonic period is very important for all animals, because most major anatomical structure begin to develop during this time. The heart is the first organ to function in the embryo and blood begins to circulate between day 25 and 30 days of pregnancy.The heart is relatively large during this period compared to body size. There are reports of the use of biparietal parameters of the skull and trunk diameter for estimating gestational age in sheep and goats (1-3, 14), but the correlations between heart diameter and gestational age have not been reported previously in ewes. In our investigation transrectal ultrasonographic examination was a reliable tool to estimate gestational age between days 40 and 100 of pregnancy, and the estimation of gestational age by fetal heart diameter was as reliable as by biparietal and trunk diameters.

Tab. 1. Correlation between estimated gestational age and actual gestational age with measured BPD, BD and FHD in the first stage of the study

	Actual gestational age	Estimated gestational age as BPD	Estimated gestational age as BD	Estimated gestational age as FHD
Actual gestational age	1.00000*	0.99*	0.99*	0.99*

Explanation: * – $p \leq 0.01$

Tab. 2. Correlation between estimated gestational age and actual gestational age with measured BPD, BD and FHD in the second stage of the study

	Estimated gestational age as BPD	Estimated gestational age as BD	Estimated gestational age as FHD
Actual gestational age	0.91*	0.97*	0.89*

Explanation: as in tab. 1.

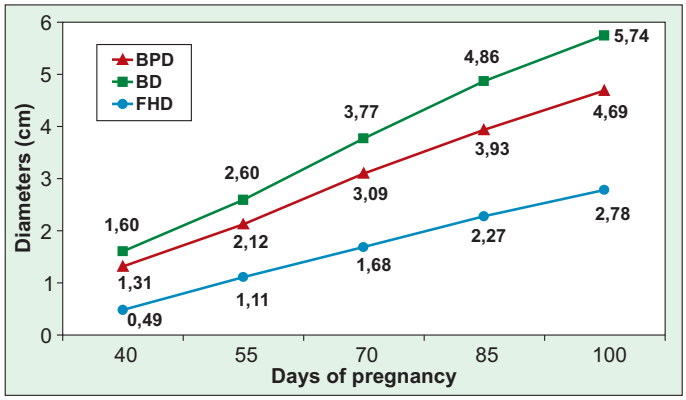

Fig. 1. Increase in values of the fetal heart diameter (FHD = ●), diameter of the body trunk (BD = ■) and biparietal diameter of the skull (BPD = ▲) according to days curve ($p \geq 0.01$)

Aiumlamai et al. (1) reported that the heart rate, diameter of the body trunk and biparietal diameter of the skull were correlated with fetal age, and it was concluded that these measurements could be used to estimate the age of the fetus. However, Chavez et al. (3) suggested that fetometry is more appropriate for determining gestational age and predicting parturition than measuring the fetal heart rate. The study revealed positive correlations between estimated and actual gestational ages determined by fetal heart, biparietal and body trunk diameters ($p \leq 0.01$).

Hata et al. (6) concluded that intrauterine sonography in humans provides additional information for estimating gestational age early on during the first trimester of pregnancy. In our study the data indicated the same results. But fetal heart diameter was detected cearly from days 40 to 100 of gestation.

In previous investigations Oral and Alaçam (13) demonstrated that only ± 0.68 days of variation were evident between the estimated and actual gestational age. In this investigation variation was determined to be ± 0.025 days between the estimated and actual gesta-

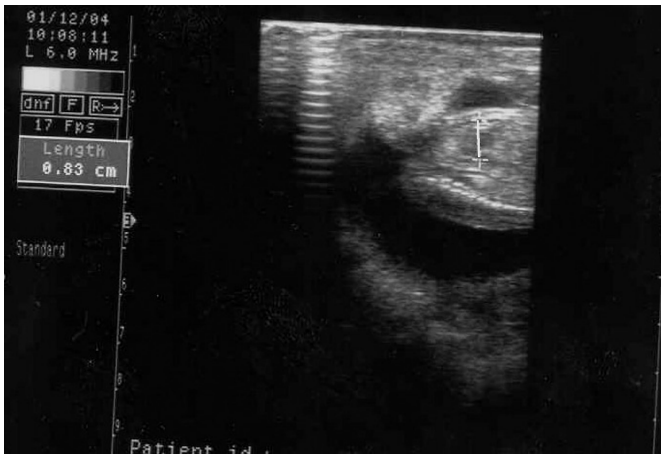

Fig. 2. View of fetal heart diameter (FHD) of fetus on day 49 of pregnancy

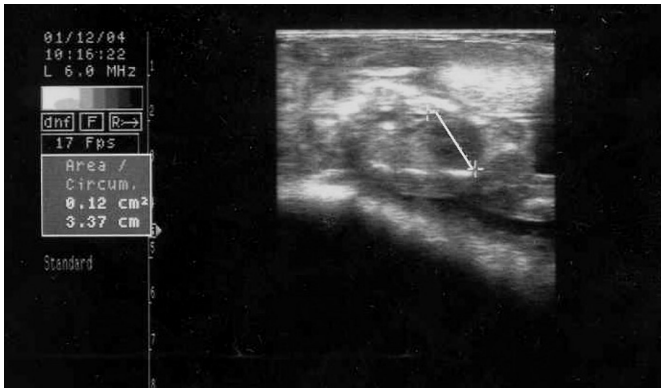

Fig. 3. View of fetal heart diameters (FHD) of fetus on day 57 of pregnancy

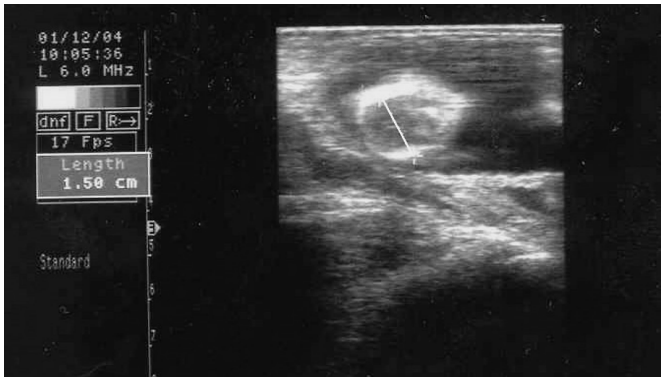

Fig. 4. View of biparietal diameter of the skull (BPD) of fetus on day 49 of pregnancy

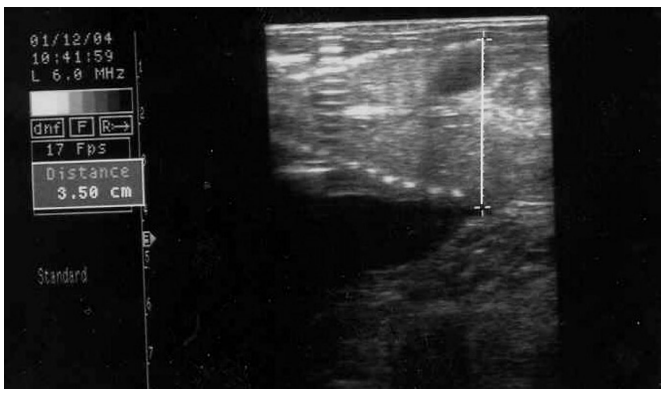

Fig. 5. View of diameter of the body trunk (BD) of fetus on day 61 of pregnancy

tional age. Santiago-Moreno et al. (15) suggested that determining gestational age transrectally was indicated to be more reliable (94 per cent). In our investigation it was more reliable from day 40 to 100 of gestation. In recent studies researchers reported that 3.5 and 7.5 MHz probes were reliable for determining gestational age (7, 9, 11, 15). In our investition we suggsted that 6 MHz probes was useful for determining gestational age. It was concluded that real-time ultrasonography is a potentially valuable aid for managing sheep flocks. Determining gestational age may be useful for the nutritional manegement of the flock during the pregnancy period. If breeding data are not recorded or missing, determining gestational age can be of great practical and economic value.

In conclusion, transrectal ultrasonographic examination was a reliable tool to estimate gestational age between days 40 and 100 of pregnancy, and estimatiing gestational age by fetal heart diameter was as reliable as by biparietal and trunk diameters.

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Author's address: Dr. Hasan Oral, Department of Obstetrics and Gynaecology, Faculty of Veterinary Medicine, Kafkas University, 36100 Kars, Turkey; e-mail: horal33@hotmail.com