



Ultrasound fetal measurement parameters for early estimate of gestational age and birth weight in ewe⁽¹⁾

(Parâmetros de medição fetal pela ultrasonografia para estimar a idade da gestação e o peso ao nascimento em ovelhas)

"Artigo Científico/Scientific Article"

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Abstract

This study aimed at creating regression equations capable of predicting gestational age and birth weight, based on parameters of fetal measurement. Was examined 164 fetuses, being 66 Dorper (27 males; 39 females), 64 Morada Nova (8 males; 56 females), and 34 Damara (14 males; 20 females), on gestation days 30 and 45. Was measured the parameters crown-rump length (CCC), area of the fetus (AF), perimeter of the fetus (FP) and volume of the fetus (VF); area of the embryo vesicle (AV), perimeter of the embryo vesicle (PV) and volume of the embryo vesicle (VV). Gestational age was correlated ($P < 0.05$) with fetal and vesicle measurements. The fetal determination coefficient was always higher than the embryo vesicle coefficient, especially regarding the crown-rump length, which was more reliable. Based on the evaluated correlations, we generated multiple regression equations for each breed, which allowed us to estimate the date of delivery after each fetal and vesicle measurement carried out on the 30th and 45th day of pregnancy. We also created multiple regression equations for each breed, to estimate gestational age according to variables of the fetuses and of the embryo vesicle. Correlations used to estimate birth weight, were low or negative for days 30 and 45 of pregnancy. Based on the results herein reported we conclude that ultrasound associated with specific linear regression equations, can be used to determine the gestational age of ewes.

Key-words: ultrasound, fetal measurement, ewe.

Resumo

Este estudo foi realizado visando elaborar equações de regressão capazes de prever a idade gestacional e o peso da cria ao nascimento, com base em parâmetros de medida fetal. Foram examinados 164 fetos, sendo 66 Dorper (27 machos; 39 fêmeas), 64 Morada Nova (8 machos; 56 fêmeas), e 34 Dâmara (14 machos; 20 fêmeas), nos dias 30 e 45 de gestação. Foram utilizados os parâmetros de comprimento crânio-caudal (CCC), área do feto (AF), perímetro do feto (FP) e volume do feto (VF); área da vesícula do embrião (AV), perímetro da vesícula do embrião (PV) e volume da vesícula do embrião (VV). A idade gestacional foi correlacionada ($P < 0,05$) com medidas do feto e da vesícula. O coeficiente de determinação fetal foi sempre mais elevado do que o coeficiente da vesícula do embrião, especialmente a respeito do comprimento crânio-caudal, que obteve resultados mais confiáveis. Baseados nas correlações avaliadas foram geradas equações de regressão múltipla para cada raça, que permitiu que fosse estimada a data do parto após cada medida fetal e vesicular realizada no 30^o e 45^o dia de prenhez. Foram também criadas equações de regressão

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múltipla para cada raça visando estimar a idade gestacional, de acordo com variáveis dos fetos e da vesícula do embrião. As correlações usadas para estimar o peso da cria ao nascimento foi baixo ou negativo para os dias 30 e 45 de gestação. Baseado nos resultados acima relatados conclui-se que o ultra-som associado com as equações específicas de regressão linear pode ser usado para determinar a idade gestacional de ovelhas.

Palavras-chave: *ultrassom, mensuração fetal, ovelha.*

Introduction

Reproductive assessment plays an important role in production increase, because most reproductive failures are due to death during pregnancy or due to pregnancy expectation in females with false pregnancy (SMITH et al., 1995). Therefore, an efficient method capable of diagnosing early pregnancy and maximizing the reproductive efficiency of the herd is of utmost importance (SANTOS, 2003).

In the case of small domestic ruminants, a number of methods for pregnancy diagnosis are reported in technical and scientific literature. (ISHWAR, 1995; FREITAS and SIMPLÍCIO, 2002; SANTOS, 2003). However, most methods do not allow for early pregnancy diagnosis, nor are they feasible, and some require handling by skilled professionals (FREITAS and SIMPLÍCIO, 2002). The methods more used are: observation of estrous failure in post-breeding does, abdominal palpation, biopsy, vaginal smears and vaginal biopsies, laparoscopy, radiography, determination of serum protein and hormone levels, A-scan and B-scan ultrasound (ISHWAR, 1995; FREITAS and SIMPLÍCIO, 2002).

Since its introduction B-scan ultrasound has been used in large scale to monitor the reproductive status of goats and sheep. B-scan ultrasound examination is popular because it is easy to use, highly efficient in early pregnancy diagnosis, with the possibility of determining gender (REICHENBACH et al., 2004; SANTOS et al., 2004a), and estimating fetal age and weight (CLOETE, 1939; WALLACE, 1948; EATON, 1952; EVANS and SACK, 1973; RICHARDSON et al., 1976; ROBINSON, 1977; ROBINSON et al., 1977; KADU and KAIKINI, 1987; MUFTI et al., 2000; MESSIAS et al., 2004; SANTOS et al.,

2004b), factors that are relevant for any type of breeding industry (MESSIAS et al., 2004; SANTOS et al., 2004b).

The position and orientation of the fetus in relation to the transducer, and the gestational age determine which structure of the body will be measured (WHITE et al., 1989). Between 40 and 100 days of gestation ultrasound can be used to determine the fetal age based on crown-rump length and biparietal diameter (HAIBEL, 1988; REICHLER and HAIBEL, 1991). In addition to these measurements, other ultrasonographic parameters such as, crown-rump length, or cranio-caudal length, and femur length are used to determine the fetal age in human medicine (SAUERBREI et al., 1992).

In view of the inexistence of reports using the crown-rump length (CCC), area of the fetus (AF), perimeter of the fetus (FP) and volume of the fetus (VF); area of the embryo vesicle (AV), perimeter of the embryo vesicle (PV) volume of the embryo vesicle (VV), our aim was to determine certain fetal ultrasound measurement parameters for early determination of fetal age and weight of ovine fetuses of the Dorper, Damara e Morada Nova breeds.

Material and Methods

This research was carried out at the “Estação Experimental de Pendência” of the “Empresa Estadual de Pesquisa Agropecuária da Paraíba (EMEPA-PB)” in the municipality of “Soledade” in the region of “Cariris Velho Paraibano” in the State of Paraíba, between April and June, 2005.

For the purpose of this study we monitored 164 fetuses of the following breeds: 66 (27 males; 39 females) Dorper, 64 (08 males; 56 females) Morada Nova and 34 (14 males; 20 females) Damara. The 98 does were naturally breed and subjected to semi-intensive husbandry practices. In the

stables they were fed balanced feed and Indian Fig Opuntia (*Opuntia ficus indica*), species of cactus and a long-domesticated crop plant important in agricultural economies throughout arid and semiarid parts of the world, on pasture they had access to native vegetation of the caatinga (type of vegetation, and an ecoregion characterized by this vegetation in the northeastern part of Brazil), water and salt *ad libitum*.

One professional was responsible for ultrasound evaluation using the model 240 Parus (*Pie Medical Equipment - Maastricht/Netherlands*). The ultrasound scanner was equipped with a linear transducer (6.0 and 8.0 MHz) adapted on a PVC support to facilitate handling of the animal's rectum, as suggested by Oliveira et al. (2004). Images were printed using a Seikosha PV/1200-Sony printer (*Sony, Tokyo - Japan*).

Fetuses were examined at 30 and 45 days of pregnancy. The following parameters were measured: crown-rump length (CCC), area of the fetus (AF), perimeter of the fetus (FP) and volume of the fetus (VF); area of the

embryo vesicle (AV), perimeter of the embryo vesicle (PV) volume of the embryo vesicle (VV).

Data was evaluated by single and multiple linear regression and single and multiple linear correlation using the Minitab for windows version 11.1332.

Results

Gestational age was correlated with (P < 0.05) fetal and vesicle measurements. The fetal determination coefficient was always higher than the embryo vesicle coefficient, especially regarding the crown-rump length, which was more reliable (Table 1).

Based on the assessment of correlations (Table 1), we created multiple regression equations for each breed. These equations allowed us to estimate gestational age according to variables of the fetuses (Table 2) and of the embryo vesicle (Table 3). Regarding the correlations used to estimate birth weight, the outcome was low (Table 4) or negative (Table 5) for days 30 and 45 of pregnancy.

Table 1 – Results of the correlations (R²) between gestational age (IG) and fetal and vesicle measurements according to breed at 30 and 45 days of pregnancy.

Breed	Structures	R ²			
		Crown-rump length	Perimeter	Area	Volume
Dorper	Fetus	0.96	0.94	0.94	0.89
	Vesicle	-----	0.9	0.88	0.82
Morada Nova	Fetus	0.96	0.96	0.96	0.93
	Vesicle	-----	0.95	0.93	0.91
Dâmara	Fetus	0.94	0.95	0.91	0.85
	Vesicle	-----	0.92	0.92	0.85

Table 2 – Multiple regression equation of gestational age estimated according to fetus variables at 30 and 45 days of pregnancy.

Breed	Variables	N ^o of Fetus	Regression Equation (Ŷ)	R ²
Dorper	CCC/FP/AF/VF	66	IG= 23.2+3.28 CCC+0.715 FP+2.40 AF+0.489 VF	0.94
Dâmara	CCC/FP/AF/VF	34	IG = 18.1+2.71CCC+1.39 FP+0.957 AF +0.566 VF	0.93
Morada Nova	CCC/FP/AF/VF	64	IG= 24.8 + 3.02CCC +0.33 F P+ 0.68 AF + 0.067VF	0.94

(CCC) crown-rump length; (FP) perimeter of the fetus; (AF) area of the fetus; (VF) volume of the fetus

Table 3 - Multiple regression equation of gestational age estimated according to embryo vesicle variables at 30 and 45 days of pregnancy.

Breed	Variables	N ^o of Fetus	Regression Equation (Ŷ)	R ²
Dorper	PV/AV/VV	56	IG = 21.1 + 0.655 PV + 1.46 AV + 0.250 VV	0.82
Dâmara	PV/AV/VV	34	IG = 22.5 + 0.542 PV + 1.58 AV + 0.147 VV	0.87
Morada Nova	PV/AV/VV	64	IG = 22.7 + 1.01 PV + 0.257 AV + 0.0380 VV	0.91

(PV) perimeter of the embryo vesicle; (AV) area of the embryo vesicle; (VV) volume of the embryo vesicle.

Table 4 - Correlation results (R²) between the structure dimensions of the fetus and weight of the kids when being born, in the studied races at 30 and 45 days of pregnancy.

Breeds	Fetuse							
	R ² - 30 days				R ² - 45 days			
	CCC	FP	AF	VF	CCC	PF	AF	VF
Dorper	0,09	0,15	-0,13	-0,16	-0,40	-0,32	-0,21	-0,09
Morada Nova	0,44	0,38	0,24	0,27	-0,11	-0,15	-0,16	-0,10
Dâmara	-0,08	-0,13	-0,36	-0,35	-0,30	-0,45	-0,49	-0,54

(CCC) crown-rump length; (FP) perimeter of the fetus; (AF) area of the fetus; (VF) volume of the fetus.

Table 5 - Correlation Results (R²) between the weight of the kids when being born and vesicle measurements according to each breed at 30 and 45 days of pregnancy.

Breeds	Embryo Vesicle							
	R ² - 30 days				R ² - 45 days			
	PV	PV	PV	PV	PV	PV	PV	PV
Dorper	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34
Morada Nova	0,384	0,384	0,384	0,384	0,384	0,384	0,384	0,384
Dâmara	0,201	0,201	0,201	0,201	0,201	0,201	0,201	0,201

(AV) Embryo vesicle area; (PV) Embryo vesicle perimeter; (VV) Embryo vesicle volume.

Discussion

A comparison of the results of this study with literature reports is difficult, due to the small amount of research with similar methodology and objectives carried out in small ruminants. Nevertheless, the quality of the images obtained with a linear allow for the identification and measurement of structures of the fetus and of the embryo vesicle.

In the beginning was expected the measurements to be effective for both the concept and the embryo vesicle, so that was could formulate an equation capable of determining gestational age and estimating birth weight. However, this hypothesis was not confirmed in relation to birth weight, probably due to the gestational period when

the exams were performed and to the small number of repetitions.

Fetal growth is slower in the first third of pregnancy when compared to the last third (COSTA, 1996). The difference in growth rate might hinder or impede the formulation of an equation that meets this objective, especially when measurements are made only on two occasions. Regarding the estimate of birth weight, a study in which more exams were performed (BLAIR, 1996) reports that the efficiency of fetal parameter measurements is higher in the last third of pregnancy. The data reported herein do not support a statement by Benson and Doubilet (1999), who claim that equation precision increases when more than one measurement

of the fetus is included. Data reported herein, which include multiple correlations containing information on the fetus and on the embryo vesicle, have not shown statistic significance.

The results show that it is possible to estimate gestational age based on fetal and embryo vesicle measurements. Yet, it is still interesting to point out that fetal measurements were more efficient in estimating the date of delivery, especially those of CCC. This is in accordance with reports by de Kähn (1992), Chalhoub et al. (1998), González de Bulnes et al. (1998), Souza (2000) and Léga (2004). Despite the high correlation this measurement cannot be used after the first third of pregnancy, when the fetus is too large for CCC measurement. This is also in accordance with Kähn et al. (1989) and Schrick and Inskeep (1993).

As reported in previously mentioned studies (GONZÁLES de BULNES et al., 1998), this study clearly showed that the association between the assessed parameters increases the degree of confidence of the equation formulated to determine gestational age. On the other hand, our results are contrary to data reported by Souza (2000) and Ramos et al. (2007), who claims that one measurement is enough to determine gestational age.

Based on these results we conclude that ultrasound and specific linear regression equations, are effective to determine gestation age of ewes, but are not reliable to estimate birth weight regardless of the breed.

References

BLAIR, E. Why do aboriginal newborns weigh less? Determinants of birthweight for gestation. **Journal of Paediatrics and Child Health**, v.32, n.6, p.498-503, 1996.

BENSON, C.S.; DOUBILET, P.M. Medidas fetais, crescimento fetal normal e anormal. In: RUMACK, C.M. et al. **Tratado de Ultrasonografia Diagnóstica**. 2^a. ed. Rio de Janeiro: Guanabara Koogan, 1999. v.2, p.859-874.

CHALHOUB, M. et al. Correlação entre comprimento crânio-caudal e medidas fetais realizadas através da ultra-sonografia na espécie

ovina. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 35, 1998. Botucatu. **Anais...** Botucatu: Sociedade Brasileira de Zootecnia, 1998. CD-ROOM.

CLOETE, J.H.L. Prenatal growth in the Merino sheep. **Onderstepoort Journal of Veterinary Science and Animal Industry**, v.13, p.417-557, 1939.

COSTA, R.G. **Exigências de minerais para cabras em gestação**. Jaboticabal, 1996. 88f. Tese (Doutorado em Zootecnia) - Faculdade de Ciências Agrárias e Veterinárias, Universidade Estadual Paulista.

EATON, O.N. Weight and length measurements of fetuses of karakul sheep and of goats. **Growth**, v.16, p.175 -187, 1952.

EVANS, H.E.; SACK, W.O. Prenatal development of domestic and laboratory mammals: growth curves, external features and selected references. **Anatomy Histology and Embriology**, v.2, p.11-45, 1973.

FREITAS, V.J.F.; SIMPLÍCIO, A.A. Transferência de embriões em caprinos. In: GONÇALVES, P.B.D. et al. **Biotécnicas aplicadas à reprodução animal**. São Paulo: Varela, 2002. Cap 9, p.179-194.

GONZÁLES de BULNES, A. et al. Estimation of fetal development in Manchega dairy ewes by transrectal ultrasonographic measurements. **Small Ruminant Research**, v.27, p.243-250, 1998.

HAIBEL, G.K. Real-time ultrasonic fetal head measurement and gestacional age in dairy goat, **Theriogenology**, v.30, n.6, p.1053-1057, 1988.

ISHWAR, A.K. Pregnancy diagnosis in sheep and goats: a review. **Small Ruminant Research**, v.17, n.4, p.37-44, 1995.

KADU, M.S.; KAIKINI, A.S. Prenatal development of caprine foetus. **Indian Journal Animal Science**, v.57, n.9, p.962-969, 1987.

KÄHN, W. Sonographic fetometry in the bovine. **Theriogenology**, v.31, p.1105-1121, 1989.

KÄHN, W. et al. Sonography during the pregnancy of sheep. I. Fetometry for the determination of the stage of gestation and prediction of the time of parturition. **Deutsche Tierärztliche Wochenschrift**, v.99, n.11, p.449-452, 1992.

- LÉGA, E. **Determinação da idade gestacional por meio das técnicas ultra-sonográficas de fetometria e morfologia fetal em cabras da raça saanen, a partir do 6º dia após o acasalamento.** 81f. (Doutorado em Cirurgia Veterinária) – Faculdade de Ciências Agrárias e Veterinárias, Universidade Estadual Paulista.
- MESSIAS, J.B. et al. Estimativa da idade e do peso embrionário e fetal através da ultra-sonografia. In: SANTOS, M.H.B. et al. (Eds.) **Diagnóstico de gestação na cabra e na ovelha.** São Paulo: Varela, 2004. p.149-157.
- MUFTI, A.M. et al. Prenatal development of ovine fetus. **Small Ruminant Research**, v.38, p.87-89, 2000.
- OLIVEIRA, M.A.L. et al. Aplicabilidade do Scan B na reprodução de pequenos ruminantes. In: SANTOS, M.H.B. et al. **Diagnóstico de gestação na cabra e na ovelha.** São Paulo: Varela, 2004. p. 85-96.
- RAMOS, A.K.M.R. et al. Avaliação dos Parâmetros Ecográficos de Desenvolvimento Gestacional de Ovinos da Raça Santa Inês. **Ciência Animal Brasileira**, v.8, n.3, 2007.
- REICHLER, J.K.; HAIBEL, G.K. Ultrasonic biparietal diameter of second trimester pygmy goat fetuses. **Theriogenology**, v.35, n.4, p. 680-694, 1991.
- REICHENBACH, H.D. et al. Sexagem fetal na cabra e na ovelha por ultra-sonografia. In: SANTOS, M.H.B. et al. (Eds.) **Diagnóstico de gestação na cabra e na ovelha.** São Paulo: Varela, 2004. p.117-136.
- RICHARDSON, C. et al. Estimation of the development age of the ovine fetus and lamb. **Veterinary Record**, v.99, p.22-26, 1976.
- ROBINSON, J.J. The influence of maternal nutrition on ovine foetal growth. **Proceedings of the Nutrition Society**, v.36, n.1, p. 916, 1977.
- ROBINSON, J.J. et al. Studies on reproduction in prolific ewes. I. growth of the products of conception. **Journal of Agricultural Science**, v.88, p.539-552, 1977.
- SANTOS, M.H.B. **Principais métodos de diagnóstico de gestação em pequenos ruminantes domésticos.** Lavras, 2003. 61f. Monografia (Curso de Medicina Veterinária) – Departamento de Medicina Veterinária, Universidade Federal de Lavras.
- SANTOS, M.H.B. et al. Diagnóstico de gestação por ultra-sonografia de tempo real. In: SANTOS, M.H.B. et al. (Eds.) **Diagnóstico de gestação na cabra e na ovelha.** São Paulo: Varela, 2004a. p.97-116.
- SANTOS, M.H.B. et al. Medidas do concepto utilizadas na prática ultra-sonográfica de pequenos ruminantes. In: SANTOS, M.H.B. et al. (Eds.) **Diagnóstico de gestação na cabra e na ovelha.** São Paulo: Varela, 2004b. p.117-136.
- SAUERBREI, E.E. et al. **Ultrasonografia em ginecologia e obstetrícia (um guia prático).** Porto Alegre: Artes Médicas, 1992. p.183-192.
- SCHRICK, F.N.; INSKEEP, E.K. Determination of early pregnancy in ewes utilizing transretal ultrasonography. **Theriogenology**, v.40, p.295-306, 1993.
- SMITH, E.J. et al. Results of the Ulysses fast latitude scan: Magnetic field observations. **Geophysical Research Letters**, v.22, p.3325, 1995.
- SOUZA, D.M.B. **Avaliação ultra-sonográfica do crescimento fetal em caprinos.** Recife, 2000. 54f. Dissertação (Mestrado em Medicina Veterinária) - Departamento de Medicina Veterinária, Universidade Federal Rural de Pernambuco.
- WALLACE, L.R. The growth of lambs before and after birth in relation to the level of nutrition. **Journal of Agricultural Science**, v.38, p.17-302, 1948.
- WHITE, I.R. et al. Diagnosis of pregnancy and prediction of fetal age in red deer by real-time ultrasonic scanning. **Veterinary Record**, v.124, p.395-397, 1989.