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Ultrasonographic pregnancy diagnosis and litter size determination in Sudanese Nubian goats

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ABSTRACT

The present study was conducted on 86 Nubian goats to evaluate the accuracy of real-time ultrasonography for pregnancy diagnosis and fetal quantification. In this study, animals were fasted for 12 hrs and the ventral abdomen was clipped and shaved carefully. Real-time scanner (Pie medical Easote, Holland) with switchable frequency (3.5-5) MHz convex and (5-7.5) MHz micro convex probe was used while the animals were properly restrained on a dorsal recumbency on a special designed table. The sensitivity (Se), specificity (Sp) and overall accuracy of the method for detecting pregnancy status were 100, 94.3 and 96.5% respectively. The Se, Sp, positive predictive value (PPV) and negative predictive value (NPV) for determining single feti were 86.9, 69.2, 88.3 and 75% respectively. Regarding diagnosis of twin feti, the Se, Sp, PPV and NPV were as follows: 90, 88.4, 75 and 95.8% respectively. The overall accuracy for all predictions was found to be 80.5%. In conclusion B-mode real-time ultrasound was found to be highly efficient, reliable and non-time consuming method for detecting pregnant goats. In conclusion real time ultrasound is considered rapid, practical and accurate means for predicting pregnancy and quantifying fetal numbers in Nubian goats. However; rescanning and follow up of the pregnant animals is recommended to exclude false positives, false negatives and early embryonic death.

INTRODUCTION

Much of the world's goat population is found in the least industrialized parts of the world, predominantly in the rural areas of the tropical and subtropical zones with nutritionally unfavorable conditions (Holtz, 2005). In Sudan there are about 40.5 million heads of goats (FAO, 2009). Four local breed types are known in Sudan; Desert,

Nubian, Nilotic dwarf and Tegri (Ibrahim, 2000). Nubian goats are among the best dairy breeds in Africa and are reputed as good milk producers in Sudan (Hassan and Elderani, 1990). The majority of Nubian goats are reared in the northern part of the country, north of latitude 12 N°. This breed plays an important role in the life of many families as a favorite animal kept for milk production (Abdelatif *et al,* 2009). Early, accurate and rapid diagnosis of pregnancy and fetal quantification through ultrasonography is of considerable value for efficient reproductive management by limiting the number of non-productive days, and contributing to rationalize management and financial benefits to production (Gonzalez *et al.,* 2004; Romano and Christian, 2008; Suguna et al., 2008; Dias et al., 2009, Airina *et al.,* 2011). In the last decade, transabdominal ultrasonography has become an important tool in veterinary medicine for the evaluation of the intrauterine life of the fetus (Serin et al., 2010). When the date of mating is unknown, monitoring fetal development allows estimation of gestational age which is important for appropriate prenatal management (Lee *et al*., 2005; Santiago-Moreno *et al.,* 2005). Applications of transabdominal real-time ultrasonography as a research tool for the study of reproduction in goats represent a technological breakthrough; it has revolutionized the medical and industrial field (Medan and Abd- El- Aty 2010; Gonzalez-Bulnes et al., 2010). Transabdominal scanning has proved to be efficient and reliable method for scanning of pregnant goat under field conditions (Koker et al., 2012). In Sudan there are few reports concerning the use of real time ultrasonography in goats. It was used to predict the pregnancy status, litter size and fetometry in Saanen goats (Abdelghafar et al., 2007a; Abdelghafar et al., 2007b; Abdelghafar et al. 2010; Abdelghafar *et al*, 2011, Abdelghafar et al, 2012), in Damascus goats (Abdelghafar et al., 2009), for diagnosis of hydrometra and pyometra (Ahmed *et al*., 2010) and for diagnosing fetal mortality (Abdelghafar, 2010). In Nubian goats it was used to monitor uterine involution (Badawi, et al 2014).

The aim of the present study was to evaluate the sensitivity, specificity, PPV, NPV and overall accuracy of real-time ultrasonography for pregnancy diagnosis and fetal quantification in Nubian goats.

Materials and methods

Experimental Animals

This study was conducted at the Veterinary Teaching Hospital, College of Veterinary Medicine, Sudan University of Science and Technology. Eighty six Nubian goats of unknown date of mating, 3-7 years old and weighing 20-35 kg were purchased from the local market and used in the present study.

Animal Preparation

Animals were deprived of food for 12 hrs prior to the scanning to avoid accumulation of gases in the gastrointestinal tract. The area of scanning which extends across the width of the abdomen, passing from one side of the udder, across in front of the udder to the other side and 15 cm anterior to the udder (Goddard, 1996) was clipped and shaved carefully using electric and manual clippers.

Ultrasound Scanning

Animals were turned on their backs (dorsal docubitus) on a specially designed table (Abdelghafar, 2011). Sufficient amount of ultrasonic gel (Primax, Germany) was applied to the area of scanning. Real time scanner (Pie medical esoate, Holland) equipped with switchable frequency (3.5-5.0) MHz curvilinear probe was used. Each goat was subjected to a single ultrasound scanning. Images were printed using Sony printer, Japan.

Experimental Design and Statistical Analysis

The experiment was designed in a completely randomized design; the chi square test ($\chi 2$) at a 5% significance level was used. Statistical analysis was carried out for evaluating the accuracy of real-time ultrasonography. Screening test such as ultrasound was used to predict physiological status (pregnancy and fetal number) by comparing the results of a diagnostic test to a cutoff point to classify individuals into one of two categories. When evaluating the discriminating power of a screening test it is important to consider various measures such as Se, Sp, PPV and NPV. A contingency table was utilized (Thrusfield, 1995). The gold standard test was delivery.

RESULTS

Pregnancy Determination

An animal was considered pregnant when fluid-filled gestational sac in the uterus (Figure 1) or fetus was demonstrated. In the present study, the (Se) of ultrasound for pregnancy diagnosis was found to be 100%; while the (Sp) was found to be 94.3%, with overall accuracy of 96.5%. Out of 86 examined does, 36 were diagnosed as pregnant and 50 as non-pregnant. The method could detect all pregnant does, however not all non-pregnant were correctly diagnosed.

Table 1: Evaluation of sensitivity, specificity, PPV and NPV of Ultrasound compared to delivery as a gold standard test

		Delivery (Gold standard test)		
		Pregnant	Non-pregnant	Total
Ultrasound outcome	Pregnant	33	3	36
	Non-pregnant	0	50	50
	Total	33	53	86

Litter Size Determination

The sensitivity Se, Sp, PPV and NPV for determining single fetuses were 86.9, 69.2, 83.3 and 75% respectively (Table 2). The Se, Sp, PPV and NPV for determining twins were 90, 88.4, 75 and 95.8% respectively (Table 3). The overall accuracy for all predictions was found to be 80.5%.

Table 2: Se, Sp, PPV and NPV for determining single fetus

		Delivery (Gold standard test)		
		One fetus	Different than one fetus	Total
Ultrasound outcome	One fetus	20	4	24
	Different than one fetus	3	9	12
	Total	23	13	36

Table 3: Se, Sp, PPV and NPV for determining twins

Ultrasound outcome		Delivery (Gold standard test)		
		Twins	Different than twins	Total
	Twins	9	3	12
	Different than twins	1	23	24
	Total	10	26	36

DISCUSSION

This study evaluated the accuracy of real-time ultrasonography for pregnancy diagnosis and determination litter size in Sudanese Nubian goats. The accuracy of real-time ultrasonography for pregnancy diagnosis was found to be 96.5%. Medan et al. (2004) found 100% accuracy for pregnancy diagnosis in Shiba goats, while Gonzalez et al. (2004) found 98.7% accuracy in Canary Islands goats. Also 100% accuracy was report (Abdelghafar, et al., 2007b; Abdelghafar et al. 2009; Abdelghafar *et al.*, 2010) in Saanen goat and Damascus goats. Airina *et al.*, (2011) examined 100 does of Jermasia and Boer cross-bred does and reported accuracy of 100%. Karen et al. (2014) found that the sensitivity and specificity of transabdominal method at 39-44 days were 93 and 75.8% respectively, 99 and 79% respectively at 46-51 days. Anwar et al. (2008) found 100% accuracy for pregnancy diagnosis in Balkhi sheep at 42 days post breeding and 97% at 75 days post breeding. Also 100% accuracy for pregnancy diagnosis was obtained by Can Gunduz *et al*., (2010) in Kivircik ewes. Yotov (2005) reported that in Stara Zagora sheep, the sensitivity and specificity for pregnancy diagnosis at 27 days post breeding were 88.1 and 81.2 % respectively; with overall accuracy 87.1%. At day 35 of gestation, the same author reported Se and Sp of 98 and 100% respectively with overall accuracy 98.36%. Lower Se and Sp for pregnancy diagnosis was also found by See *et al*. (2007) in Suffolk and Suffolk cross breed; they reported (Se) of 91% and (Sp) of 53%.

In the present study, the sensitivity was found to be 100% as the method could accurately detect all pregnant animals. However the specificity was found to be 94.3%; Fourty nine out of 52 goats were diagnosed correctly as non-pregnant and three does were erroneously diagnosed as pregnant but they did not give birth. Our judgment for the false positive diagnosis could be due to many reasons. The 1st reason is that; one doe was diagnosed as pregnant based on demonstration of uterine fluids only and no embryo was demonstrated. Accumulation of fluids inside the uterus could be associated with estrous or uterine pathology. Yotov (2005) reported that the precise diagnosis in the early stage of pregnancy should be based not only on the detection of a uterine fluid but on the presence of an embryo as well, in order to eliminate false positive diagnosis. The other two does were diagnosed as pregnant by demonstrating the fetuses and measuring their organs i.e. femur, BPD and humerus. The false positive diagnosis which is unlikely to occur could certainly be due to unnoticed abortion.

The litter size of the Nubian goats in the present study was found to be one fetus/doe compared with 1.65 fetuses per doe in Saanen goats under Sudan conditions (Abdelghafar, 2011). The overall accuracy for litter size for all predictions was found to be 80.5%. Four single and three twins were erroneously diagnosed with 19.44 error rate.

In the present study, 20 does were correctly diagnosed as bearing single feti and four does were incorrectly diagnosed as bearing single feti (one doe yielded no fetus) and one doe gave birth to twins. The three false positives were due to; unnoticed abortion (2 does) and early hydrometra (one doe). The fourth doe was scanned at about 130 days of gestation in which one fetus occupied the screen and the other one could not be visualized. Kahn (2004) stated that after day 100 of gestation, the feti are so large and lie close to each other that it becomes rather difficult to distinguish between them. Abdelghafar et al. (2007b) found that the accuracy for determining single, twins and triplet was 83.3, 77.7 and 50% in Saanen goats; they reported an overall accuracy of 79.3%. Abdelghafar et al. (2010) reported overall accuracy of 92.5 for litter size determination in 40 Saanen goats. They reported that the sensitivity and specificity for determining single feti were 100%. Regarding diagnosis of twins the Se, Sp, PPV and NPV were found to be 100, 86.3, 85.7 and 100% respectively. Abdelghafar et al. (2009) found an overall accuracy of 90.9% for all predictions. The accuracy for determining single, twins, triplets was 100, 85.7 and 50%, respectively. Haibel et al. (1989) reported that the accuracy in differentiating single fetuses from twins is higher than differentiating twins from triplets

The best time for litter size determination is between 40-100 days (Goddard, 1996). Regarding diagnosis of twins, three does were incorrectly diagnosed as bearing twins while they gave birth to only single fetus. This could partially be due to inadequate fasting of some does which laid to image artifacts and incorrect results. Decreased accuracy for pregnancy diagnosis and litter size was obtained in the present study compared with the previous studies carried out by the same sonologist. This could certainly be attributed to many factors other than the skills of the operator.

To the best of the author's knowledge this is the first article reporting the accuracy of transabdominal real-time ultrasonography for pregnancy diagnosis and litter size determination in Nubian goats in the Sudan.

Conclusion and Recommendations

Transabdominal ultrasound scanning under field conditions was found to be reliable, non-invasive and non-time consuming tool for pregnancy diagnosis and litter size determination. However early diagnosis based on demonstration of the uterine fluid without demonstrating the embryo will lead to inaccurate diagnosis; accordingly rescanning is recommended after 40 days.

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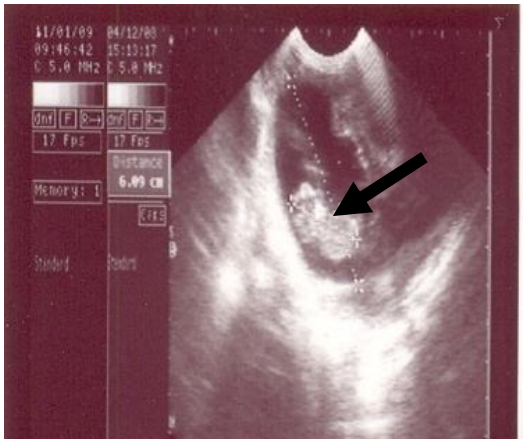

Fig. 2. Gestational sac with fetus (arrow)

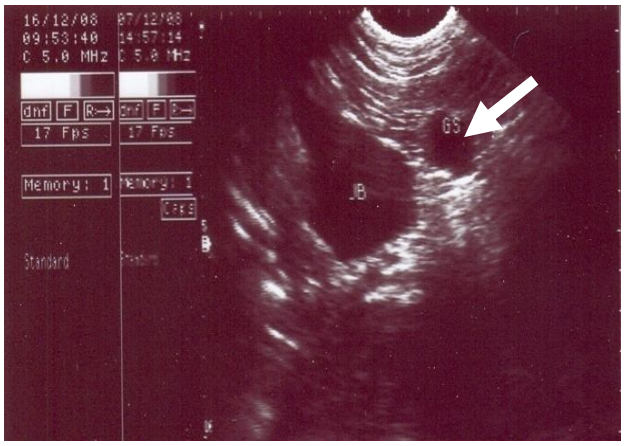

Fig. 1. Gestational sac (arrow)

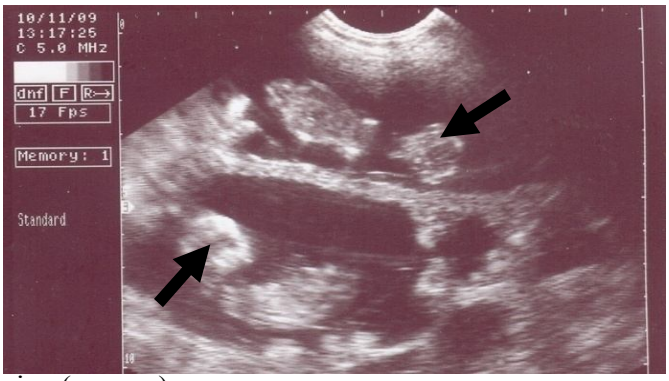

Fig. 3. Twins (arrows)