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RESEARCH ARTICLE

Assessment of postpartum uterine involution and progesterone profile in Nubian goats (*Capra hircus*)

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ABSTRACT

A total number of 12 postpartum (pp) Nubian goats were included in the study to measure the uterine involution by ultrasonography from day 3 to 31 pp. Coinciding with ultrasonography, blood samples were collected at every 3 days to monitor the ovarian activity by measuring plasma progesterone (P_4) concentration using progesterone radio-immuno-assay (RIA). Uterine diameter (UD) and uterine lumen (UL) were maximum on day 3, and minimum on day 31 pp. More than 50% of uterine involution occurred between day 3 and day 14 pp. The end of uterine involution was characterized by small UD and absence of lochia in the UL. The maximum (0.87±0.4 ng/mL) and minimum (0.54±0.2 ng/mL) plasma P_4 levels were reported on day 27 and day 7 pp, respectively. Completion of uterine involution was recorded at 22±3.3 days pp. There was a negative correlation between P_4 level and uterine parameters (UD and UL). It can be concluded that ultrasonography is a reliable tool to determine uterine involution in Nubian goats.

Keywords:

Nubian goats, postpartum period, uterine involution, ultrasonography, progesterone, radioimmunoassay

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INTRODUCTION

The goat population (about 43.3 million) in Sudan is composed of four major local breeds, *i.e.* Nubian, Desert, Nilotic, and Dwarf goats (Wilson, 1991; MARF, 2009). Nubian goats are among the best known dairy breeds in Africa especially in Sudan where they comprise 47% of the total goat population (AOAD, 1990). Nubian goats in Sudan are prolific and non-seasonal having 147 days lactation length with a milk yield of 1.5-2.0 kg per day and 150-200 kg per lactation. The body weight of Nubian goats is 50-70 kg in males and 40-60 kg in females (Ahmed et al., 2000).

The reduction in the size of the genital tract after parturition is called involution; it occurs in a decreasing logarithmic scale, the greatest change occurring during the first few days after parturition (Noakes et al., 2009). There is rapid shrinkage and contraction of the uterus, particularly during the day 3 to day 10 pp, as determined by measurements of uterine weight and length, diameter of uterine body and previously gravid horn. According to these

measurements, involution is completed by 20–25 days under normal non-pathological conditions was completed and the uterus assumed its pre-gravid size by day 19 pp in Balady goats (Degefa el al., 2006).

Ultrasonography is a useful and reliable method to monitor the uterine involution in sheep (Hauser and Bostedt, 2002; Zdunczyk et al., 2004; Hayder and Ali, 2008) and goats (Ababneh and Degefa, 2005; Takayama et al., 2010). The absence of intrauterine fluid accumulation after day 4–7 pp on ultrasonic image confirms quick regression of the uterus (Ababneh and Degefa, 2005). The end of uterine involution was characterized by a small cross-sectional diameter of uterine horns and absence of lochia in the uterus (Zdunczyk et al., 2004). The completion of uterine involution was defined as the day when the diameter of the uterus returned to the original non-pregnant size as observed during the normal estrous cycle (Takayama et al., 2010).

The interval between parturition and the first pp estrous is an important trait which contributes to the reproductive efficiency (Lindsay, 1991). Ovulation during the early pp period is associated with an increased incidence of extended luteal activity (Mitchell et al., 2003). During pp anestrous period, the progesterone concentrations remained at basal levels, fluctuating between 0.1 and 0.9 ng/mL and exhibited an increase in basal levels with the resumption of postpartum cyclicity in Dwarf goats (Khanum el al., 2007). Plasma progesterone concentration increased transiently after first ovulation but again rapidly decreased to baseline levels in non-seasonal Shiba goats (Takayama et al., 2010). First ovulation, not accompanied by estrous, in Creole goats occurred from the third week pp (Chemineau et al., 1993). Early diagnosis of uterine involution in Sudanese Nubian goats will help in early rebreeding of doe and reduce kidding interval, thus increase number of kidding per year. The objectives of this study were to determine the uterine involution and the relationship between uterine measurements (UD and UL) and P_4 levels during pp period in Nubian goats by using ultrasonography and RIA.

MATERIAL AND METHODS

Selection and management of goats: This study was conducted during the period from September 2011 to December 2012 at the farm of Sudan University of Science and Technology (SUST) at Hilat Kuku-Khartoum North ((N-15°37`11.30", E-32°33`51.35"). A total of 12 pluriparous Sudanese Nubian goats were used in this study. Their ages ranged between 5 to 8 years and body weights were between 40 to 60 kg. The (Noakes et al., 2009). Macroscopic uterine involution animals were fed on concentrates (44% sorghum, 36% wheat bran, 10% ground nut cake and 10% ground nut hulls), and alfalfa hay once a day. Water troughs (20 liters capacity) were filled with fresh water twice daily in the morning and afternoon. Mineral salt licks were made available during the whole period of the study. The goats were allowed to exercise and to graze for 4 h twice a week in an adjacent field of sorghum. The kids were allowed to suckle normally throughout the study period.

Ultrasonic examination of the postpartum uterus: Trans-rectal ultrasonographic examinations were performed on all does twice weekly, starting from day 3 pp to measure the diameter of the involuting uterine horn, using a real-time B-mode ultrasound scanner (Pie Medical, Easote, model no 411281, Holland) with a linear-array transducer of 6.0/8.0 MHz. Sonographic6pictures were documented by a video graphic printer (Sony Corporation 6-7-35, Kitashinagawa Shinagawa, Tokyo, Japan). The rectal probe was made rigid by an extension rod and gently introduced into the rectum after applying ultrasonic jelly (Aquasonic, Parker Laboratories, INC. Fairfield, New Jersey, USA). The transducer was moved medially and laterally to get the best view of the specific uterus, where the maximum diameter of the involuting uterine horn was recorded and fixed on the screen of the ultrasound (Godfrey et al., 1998; Hayder and Ali, 2008). Uterine involution was considered to be complete when no further reduction in the uterine diameter for three successive examinations was recorded, in addition to absence of lochia in the uterus (Zdunczyk et al., 2004).

Blood sampling and progesterone assay: Blood samples (5 mL) were obtained twice per week at same days of ultrasound examination of the uterus by jugular venupuncture into heparinized tubes (Lithium heparin blood collection tube 2.5 mL, HNTE-DISPO, Zhejiang, China), and immediately centrifuged at 5,000 rpm for 5 min (Hettich Zentrifugen, model no 0032572, rotor scale is 6000 U/min, Germany) for plasma separation. The plasma was pipetted into plastic tubes (eppendorf tube 1.5 mL, Haimen Shengbang Laboratory Equipment Company Ltd., Jiangsu, China) and capped, which was frozen immediately, and stored at −20°C until assayed for progesterone. Plasma P_4 concentration was measured using RIA (progesterone radioimmunoassay kit IMK-458, China Institute of Atomic Energy, Beijing). The sensitivity of the assay was 0.02 ng/mL, and the intra- and inter-assay coefficients of variation recorded were 2.5% and 3.25%, respectively.

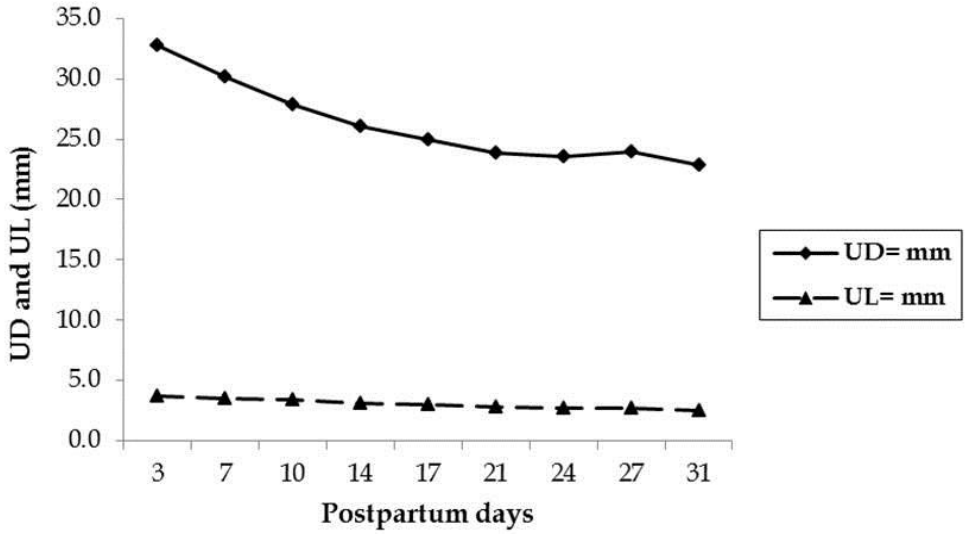

Figure 1. Mean uterine diameter (UD) and uterine lumen (UL) of 12 does from day 3 to day 31 pp ($R^2 = 0.748$; $p \leq 0.05$)

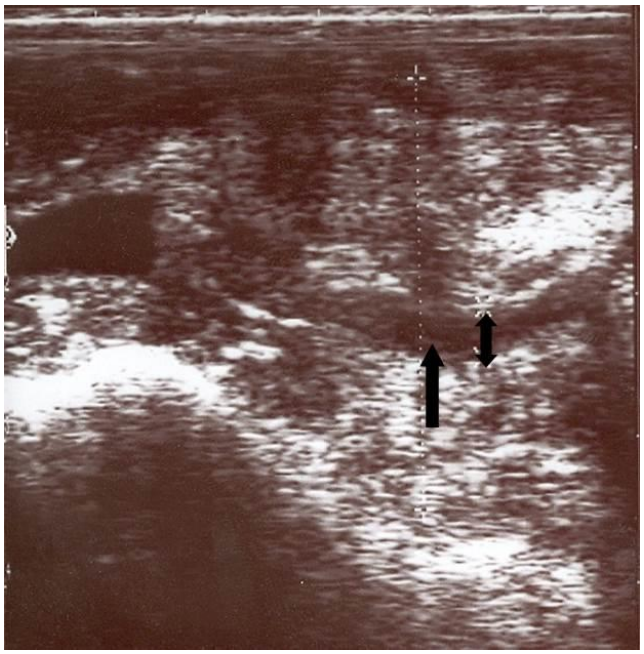

Figure 2. Uterine lumen (UL) with lochia on day 5 pp (arrows) in scanned doe

Statistical analysis: The relationship between P_4, UD and UL was determined by Correlation (Pearson) and regression (Fisher's test) analyses. The computer program Statistical Package for Social Science (SPSS) version 18 was used to analysis the data. To determine the relationship between P_4, UD and UL, the regression of uterine diameters was described by the following predictive equation:

$$y = a + b*x$$

Where; 'y' means the predictive value of UD or UL (mm); *'a','b' and 'x'* indicate the constant, the coefficient of P_4 and the value of P_4 (ng/mL), respectively during pp period.

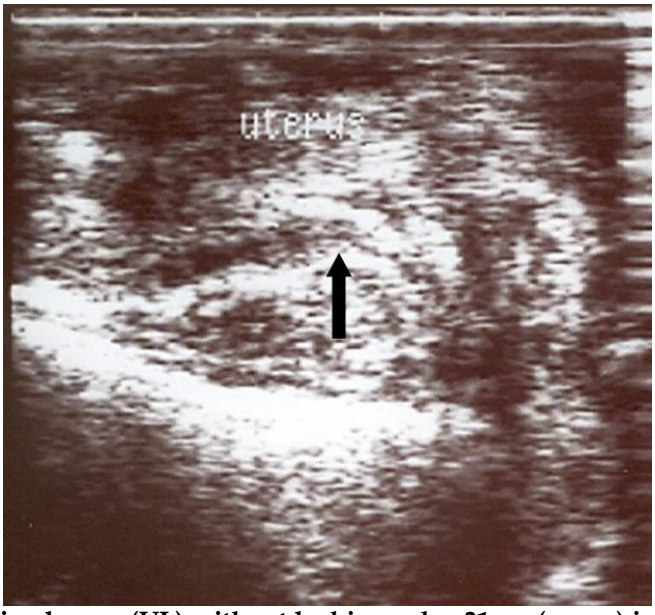

Figure 3. Uterine lumen (UL) without lochia on day 31 pp (arrow) in scanned doe.

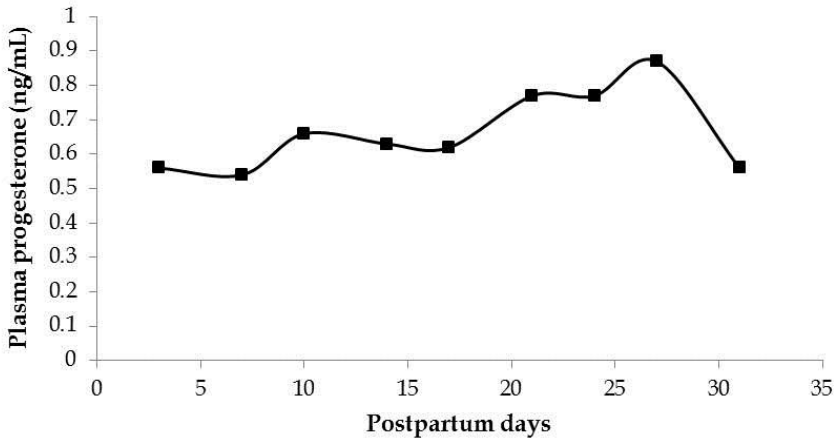

Figure 4. Mean plasma P_4 concentration (ng/mL) from day 3 to day 31 pp ($R^2 = 0.752$; $p \leq 0.05$).

RESULTS AND DISCUSSION

Postpartum uterine involution: The overall interval for complete uterine involution was 22±3.3 days. The diameter of the involuting uterine horn decreased rapidly within day 3 to day 14 pp (>50%), but more steadily from day 17 to day 27 pp (Figure 1). The uterine lumen declined gradually from day 3 until day 31 pp (Figure 1) and accumulation of uterine fluid (lochia) was noted during first week of pp (Figure 2). The end of the uterine involution was characterized by small UD (no further reduction of UD for three consecutive examinations was recorded) and absence of fluid in the UL (Figure 3). The white area seen during ultrasonography (Figures 2 and 3) indicates the image artifact which is called acoustic shadowing

Plasma progesterone profile: Mean concentration of plasma P_4 measured by RIA from day 3 to day 31 pp is shown in Figure 4. The Maximum concentration was reported on day 27 pp (0.87±0.4 ng/mL) and the minimum level was on day 7 pp (0.54±0.2 ng/mL). The P_4 level increased slowly from day 7 (0.54±0.2 ng/mL) to day 10 pp (0.66±0.1 ng/mL) and remained at this level until day 17 pp. Then, the concentration increased from day 21 (0.77±0.3 ng /mL) and reached a peak level on day 27 of pp (0.87±0.4 ng/mL) and then declined rapidly to the minimum level on day 31 pp.

Relationship between P_4 and uterine diameters (UD and UL) during postpartum period: There were negative significant correlations between level of plasma P_4 and UD on day 7, 14, 24, 27 and 31 of pp (R^2=0.596, 0.752, and 0.563; $p \leq 0.05$). Correlations were also significant between P_4 level and UL on days 17, 24, 27 and 31 pp (R^2=0.609, 0.941 and 0.784; $p \leq 0.05$). This shows that, the high concentration of P_4 on day 24 pp was followed by the minimum diameter of uterus and uterine lumen. This supports the results described by Rubianes and Ungerfeld (1993), who observed that first increase of P_4 level occurred after complete uterine involution in Corriedale ewes. However, Hayder and Ali (2008) recorded no correlations between the time of uterine involution and the onset of pp luteal function. The results indicated that the P_4 concentrations increased slowly from day 7 to day 21 and reached a peak value on day 27 postpartum, but decreased rapidly to minimum levels on day 31 pp. These results are similar to Khanum et al. (2007) in Dwarf goats and Takayama et al. (2010) in Shiba goats during pp period.

There was a rapid decline in UD from day 3 to day 14 pp. During this period, more than 50% of the size of the uterus was regressed. This is in agreement with the report of Hayder and Ali (2008) in Farafra sheep, who found an enormous decrease in uterine diameter during first two weeks following parturition (more than 50%). This result disagrees with the finding in German sheep (Hauser and Bostedt, 2002), who reported more than 80% uterine involution occurred during first 11 days pp. Ababneh and Degefa (2005) reported that majority of uterine involution occurred during one week in Balady goats. The difference could be due to the variation in climate and management. The ultrasonographic investigation allows the assessment of the uterine cavity and the echogenicity of the lochia (Hauser and Bostedt, 2002). Corresponding to the rapid regression of the UD, the present study reported similar reduction of the uterine lumen because of the contraction of the myometrium. The lochia was observed during 4-7 days pp. These findings are similar to the previous reports in sheep (Hauser and Bostedt, 2002; Zdunczyk et al., 2004) and goats (Ababneh and Degefa, 2005).

In this study, the end of the uterine involution was determined at approximately 22 days pp. This is in accordance with Ababneh and Degefa (2005) and Takayama et al. (2010), but is in contrast to others (Rubianes and Ungerfeld, 1993; Zdunczyk et al., 2004; Hayder and Ali, 2008), who observed the end of the uterine involution after 30 days pp. Shorter (23 days) pp period was also reported previously in Nubian goats (Makawi and Badawi, 2007). However, El-Hassan et al. (2009) reported much longer duration (148 days) of pp period in Nubian breed. Longer pp period was also reported in Boer (Greyling, 2000), Anglo-Nubian, Saanen (Freitas et al., 2004), Somali (Abebe, 2008) and Nilotic goats (Atta et al., 2012). This variation in the length of the pp period could be attributed to differences between breeds, methods of measurement and effect of seasons (Greyling, 2000).

CONCLUSION

It could be concluded that ultrasonographic imaging proved to be a valuable and safe tool in monitoring uterine involution. There was a negative correlation between P_4 level and uterine parameters.

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