J. Reprod. Fert. (1988) **82,** 587–593

Printed in Great Britain

A study of the genital organs of the female dromedary (*Camelus dromedarius*)

A. B. ElWishy

Department of Surgery and Theriogenology, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt

Summary. Camels (416 pregnant, 118 non-involuted *post partum* and 730 non-pregnant) were examined *post mortem*. Large follicles (>10 mm), small follicles (5–10 mm) and non-functional ovaries were observed in 144 (20·7%), 127 (18·3%) and 424 (61·0%) respectively out of 695 normal non-pregnant organs. Season did not exert any significant influence on the frequency of these groups. Recently formed and regressing CL after sterile mating were occasionally seen. Corpora albicantia (3–15 mm) were the most frequent structures observed in non-pregnant organs of parous camels as well as in pregnant tracts, together with the CL of pregnancy: 17% of ovaries contained more than one luteal structure. Pregnancy was easily recognized as early as 40–45 days of gestation because of the marked swelling of the left uterine horn in which 99·52% of the pregnancies were located.

Keywords: dromedary; ovary; Graafian follicle; corpus luteum; early pregnancy

Introduction

The dromedary, a primary inhabitant of the arid areas of Northern Africa and South-western Asia, can be a better provider of food than the cow which is severely affected by heat and scarcity of water and food. However, full exploitation of the camel's productive capacity will only be possible when the reproductive performance is improved. A better understanding of reproductive biology of this animal is therefore needed.

In the present work the ovarian contents of camels slaughtered during the reproductive cycle were studied. Also changes in the gravid uterus during early stages of gestation, as an aid to pregnancy diagnosis by rectal palpation in live camels, were examined.

Materials and Methods

Data for the current study were gathered from post-mortem examination of the reproductive organs of 1264 camels over a period of more than 4 years. The age of these camels varied from 3 to over 20 years. Some of these camels were derived from herds maintained in yards close to the slaughterhouse for a few weeks before slaughter. A history of recent calving (a few hours to 2 weeks) or oestrus (with or without mating) was obtained for 23 and 18 camels respectively. No information on the reproductive status of the other camels was known.

Pregnant genital tracts were examined for site of pregnancy, number and location of corpora lutea and follicles >5 mm in diameter. The length and diameter of the free parts of the uterine horns were recorded to the nearest cm for a small number of samples. Fetal crown–rump length and volume of fetal fluids, to the nearest mm and ml respectively, were noted for the same samples.

Non-pregnant genital tracts were inspected carefully for gross abnormalities and for ovarian contents.

Dimensions and weight of the ovaries and diameter of ovarian structures, to the nearest mm and g, were recorded for pregnant and non-pregnant genital tracts.

Results

The material examined in the current study included 416 pregnant organs (32·9%), 118 non-involuted post-partum genital tracts (13·9%) and 730 non-pregnant specimens (53·2%).

Non-gravid genital tracts

The genital organs from non-pregnant camels included 107 specimens from heifers and 623 from parous camels; 35 tracts with gross pathological lesions were excluded.

Age and functional changes in ovarian morphology. The ovaries of anoestrous nulliparous camels are flattened, sometimes lobulated organs with an ovoid outline (Fig. 1). The medial and lateral surfaces present transparent or occasionally reddish small follicles of 3–5 mm in diameter, giving the ovary a granular appearance. The mean dimensions of the ovaries were 2·6 × 2·2 × 0·9 cm. Follicular activity that may be observed as early as 3 years of age resulted in marked distortion of the shape of the ovaries. Ovulation, indicated by the presence of regressing CL after sterile mating was noted in 4 specimens with known history of mating 12–17 days before slaughter and in 3 other specimens with unknown history.

Fig. 1. The ovaries of a 3-year-old prepubertal camel.

The mean weight of the ovaries of non-pregnant anoestrous camels varied from 2 to 7·8 g (mean 4·1 g). This variation was mainly influenced by the number and size of corpora albicantia. When large they project from the main contour of the ovary giving the latter an extremely exaggerated lobular form.

Ovarian contents. Graafian follicles of various sizes could be seen in one or both ovaries. Small follicles of 5–10 mm were observed in 127 of the non-pregnant genital tracts examined (18·3%), while large follicles > 10 mm were found in 144 (20·7%) specimens. Non-functional ovaries with no structures or with corpora albicantia of different sizes (3–15 mm) were seen in 424 specimens (61·0%). Season did not exert any significant influence on the frequency of these groups.

Mature follicles are thick-walled, turgid and transparent with clear ramification of blood vessels on the surface. They always protrude markedly above the ovarian surface. A history of oestrus without mating 24–48 h before slaughter was known for 5 camels (Fig. 2). In contrast to other farm animals the follicles cannot be ruptured by digital pressure but can be easily squeezed as discrete vesicles. The diameter of the largest follicles varied between 15 and 30 mm, but occasional follicles of 50 mm were seen.

The recently formed corpus luteum of the camel is reddish-brown in colour, with fine ramifications of blood vessels on the surface. These were observed in 5 specimens, 2 of which were known to have been mated 6 and 8 days before slaughter. In section, a central cavity containing a small amount of fluid was seen (Fig. 3). This is the only type of CL in the camel that could be enucleated from the ovary when gentle pressure was applied at its base.

Regressing corpora lutea after sterile mating were pale pink, sometimes light-brown, in colour, ovoid and firm with fine but sparse blood vessels on the surface. These were seen in 17 specimens out of which 7 had a known history of mating 13–22 days before slaughter. Their diameter varied between 4 and 12 mm and they always had small central cavities. These bodies were firmly attached to the ovarian tissue and could not be squeezed from the ovary by digital pressure.

Gravid genital tracts

Of the 416 pregnant specimens examined, the CL was located in the right ovary in 187 (44·9%), in the left ovary in 201 (48·4%) and in both ovaries in 28 (6·7%) organs. Multiple CL were observed in 71 ovaries (17·1%); most were double (66 or 93%), but 3 and 4 corpora lutea were observed in 4 and 1 of the specimens respectively.

Pregnancy was located in the left horn in 414 specimens (99·52%) and in the right in only two (0·48%). No case of twin pregnancy was observed in the material examined.

Changes in dimensions of the uterine horns during early pregnancy. At 40–45 days the free parts of the gravid (left) horn became distended to a width of 7·1 cm as compared with 5·4 cm in the quiescent stage in multiparous camels. A substantial increase up to two times the pregravid diameter occurred at 60 days of gestation (Table 1; Figs 4, 5). Up to this time the increase in diameter of the non-pregnant horn was still slight but a sudden increase to about 3 times its normal diameter was observed at 75–90 days. At 150 days the diameters of the gravid and non-gravid horns were nearly 4 times their original sizes. The increase in length of the free parts of the gravid and non-gravid uterine horns was appreciable from 60 days onwards. The amount of fetal fluids was small (285 $\pm$ 33 ml) at 40–45 days but then increased markedly until the end of the period studied.

Ovarian contents. Pregnancy in the camel is characterized by the presence of one or more well developed corpora lutea in one or both ovaries. They are reddish-brown in colour and sometimes with a violet hue. The CL markedly projects from the main contour of the ovary with well developed blood vessels ramifying on its surface. The mean size and weight of these corpora lutea are 22 mm (8–30 mm) and 4·8 g (1·2–6·2 g) respectively. The wide variation in these parameters was particularly observed in specimens with multiple CL. In section, a thin retracting whitish capsule was seen enclosing a pale pink to dark reddish-brown mass of lutein tissue and a central, sometimes eccentric, bluish-white plug.

Follicular activity was observed in 85 organs (20·4%) during different stages of gestation, but was most frequent (48·7%) during the first 90 days. The diameter of the largest follicle at any stage did not exceed 15 mm but was generally less than 10 mm.

The CL of pregnancy was frequently associated with corpora albicantia of different sizes. In many specimens the number of these bodies was much higher than the expected number of births, even bearing in mind the possibility of multiple corpora lutea.

Non-involuted post-partum genital tracts

Non-involuted uteri after parturition or abortion constituted 13·9% of the organs examined. Only 23 had a known history of recent calving within a few hours to 2 weeks before slaughter. At 24–48 h after delivery the uterine serosa was reddish-pink in colour. The uterine wall was thickened, oedematous, and non-resilient with clear longitudinal corrugations. The cervix was relaxed. The surface of the endometrium was dark brown and the uterine lumen contained a variable, but small amount of brown or chocolate-coloured, thick and viscous mucus. Foul smelling,

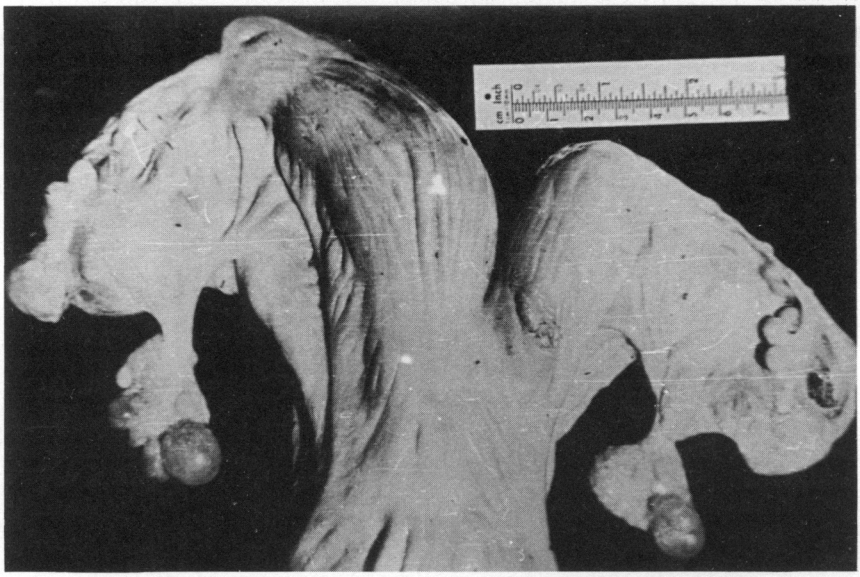

Fig. 2. The genital organs of a camel with large follicles in both ovaries.

Fig. 3. Recently formed CL (6 days after mating). The weight and diameter were 2 g and 14 mm.

greyish-yellow and watery exudate was sometimes seen. The colour of the serosa was maintained until involution of the uterus was nearly complete, while the colour of the endometrium faded to pale pink more quickly.

Ovarian contents. Corpora albicantia formed the main feature of the ovaries. Within 24–48 h after parturition the regressing corpora lutea were light brown in colour, firm and with a few blood vessels still ramifying on the surface. The diameter of these bodies ranged between 16 and 20 mm.

Table 1. Crown–rump (C–R) length of the fetus and dimensions (mean ± s.e.m.) of the uterine horns during early pregnancy in the dromedary

Estimated* period of pregnancy (days)	No. of camels	C–R length (cm)	Vol. fetal fluids (ml)	Free portions of the uterine horns			
				Left (pregnant) horn		Right (non-pregnant) horn	
				Length (cm)	Diam. at base (cm)	Length (cm)	Diam. at base (cm)
Non-pregnant†				15·0 (10·2–22·0)	5·4 (4·4–6·7)	10·6 (7–14·5)	4·2 (3·2–4·7)
40–45	3	3·3 ± 0·16	285 ± 33	14·7 ± 0·29	7·1 ± 0·26	9·8 ± 0·17	5·2 ± 0·32
60	4	5·5 ± 0·22	515 ± 60	18·2 ± 0·37	10·8 ± 0·34	12·8 ± 0·56	5·6 ± 0·25
70–90	5	11·6 ± 0·42	1800 ± 123	20·6 ± 0·75	13·1 ± 0·46	13·5 ± 0·68	11·0 ± 0·40
105–120	6	18·4 ± 0·33	3500 ± 325	29·7 ± 3·22	15·4 ± 0·78	18·2 ± 1·32	12·3 ± 0·61
135–150	12	23·7 ± 0·40	6024 ± 205	42·3 ± 2·12	21·6 ± 1·07	26·7 ± 1·51	16·2 ± 0·73

*Taken from ElWishy *et al.* (1981).
†From Mobarak & ElWishy (1971).

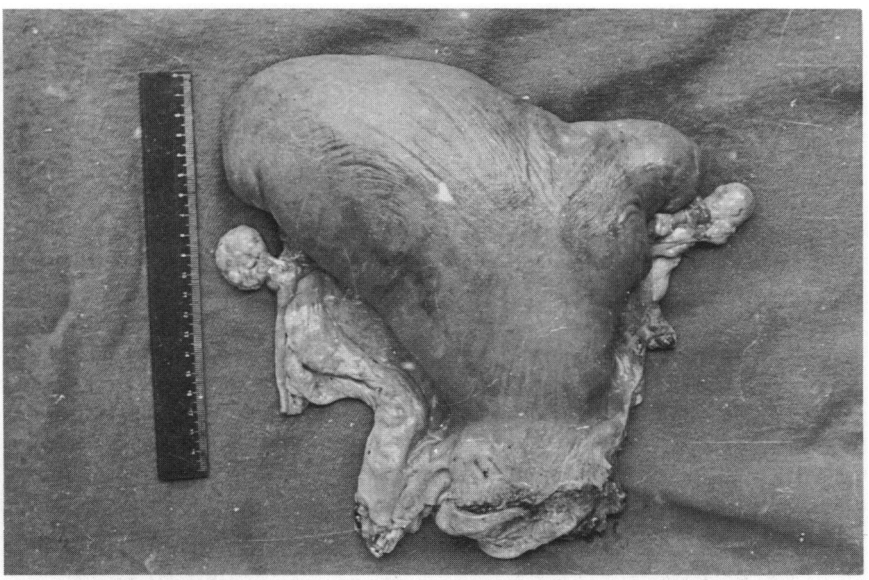

Fig. 4. A 55-day gravid uterus of a camel with a large CL of pregnancy in the right ovary.

At 1 week after parturition the diameter decreased to 12–15 mm and they appeared as knob-shaped, hard structures with bluish-white or greyish-white outer coloration and no blood vessels on the surface. Corpora albicantia of 10–12 mm in diameter together with smaller ones of 5 mm or less, which appeared as button-shaped elevations, were very frequently seen in non-involuted (2 weeks or more after parturition) as well as in completely involuted organs.

In section, small and large corpora albicantia had the same features, i.e. an external thick fibrous capsule (1–3 mm) investing light-brown zone of lutein tissue and a central irregular zone of fibrous tissue.

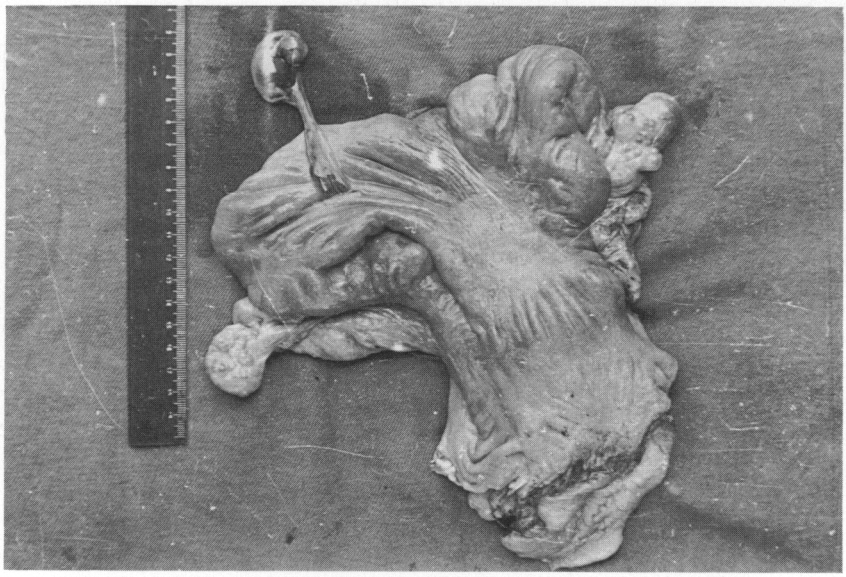

Fig. 5. The same as Fig. 4 with the fetus exposed.

Discussion

These results show that the shape and size of the ovaries of camels are markedly influenced by age and activity. In non-pregnant genital tracts the presence of follicles and/or corpora albicantia, especially when large, lead to marked irregularity of ovarian shape. The high frequency of non-functional ovaries (61·0%) in the material examined could be due to malnutrition and may account for the protracted periods of anoestrus and long calving intervals in camels described by Mugerwa (1981). These conditions are important factors contributing to low reproductive performance in camels.

The scarcity of corpora lutea in the genital tracts of non-pregnant camels can be ascribed to the induced nature of ovulation in this species (Elias *et al.*, 1984; Chen *et al.*, 1985) and the short life-span of the corpora lutea formed after sterile mating (Fernandez-Baca *et al.*, 1970; Musa & Abusineina, 1978a; Marie & Anouassi, 1987). The progesterone pattern after sterile mating in the camel, in contrast to other farm animals, is characterized by absence of a plateau and early luteolysis (Marie & Anouassi, 1987). Hence CL comparable to those of dioestrus in the buffalo, cow, mare and ewe are not seen in the camel.

Large and well developed CL were only observed during pregnancy. Therefore, determination of progesterone concentration in the blood or milk would be a valuable aid for early diagnosis of pregnancy in the camel before palpable changes in the uterus can be assessed *per rectum*. The clear increase in breadth of the left (pregnant) horn as early as 40–45 days (Table 1) conforms with the results of rectal palpation described by Banerjee *et al.* (1981). The 2-fold increase in size of the pregnant horn at 60 days agreed with the findings of Barmintsev (1951) for the Bactrian camel. However, the absence of palpable swelling of the uterus until the 8th week reported by Musa & Abusineina (1978b) can be ascribed to the pregravid size of the uterus as a function of age and parity of the camels examined.

Both the crown–rump length of the fetus and the amount of fetal fluids in the present work are less than the corresponding values reported by Perkins *et al.* (1954) and Arthur *et al.* (1982) in cattle at the same stages of gestation.

In spite of the nearly equal ovulatory activity of the right (44·9%) and left (48·4%) ovaries, pregnancy in the camel was mainly located in the left horn (99·5%), indicating a high incidence of ova or embryo migration in this species. The frequency of multiple corpora lutea of pregnancy in this study (17·1%) was within the range of 12·4–18·6% reported in other studies (Shalash, 1965; ElWishy & ElSawaf, 1971; Musa & Abusineina, 1976; Ghoneim, 1985). Multiple ovulations, ovulation during pregnancy or the co-existence of several generations of corpora lutea might account for this phenomenon in the camel. Twin pregnancies, however, were only rarely (0·13–0·40%) observed in the early stages of pregnancy (Shalash, 1965; Musa & Abusineina, 1976) and not in late stages (Musa & Abusineina, 1976; Arthur *et al.*, 1985) or at birth (Leese, 1927; Bhargava *et al.*, 1963).

Corpora albicantia represent a main characteristic of the ovaries of parous camels. They are believed to be remnants of corpora lutea of pregnancy (ElWishy *et al.*, 1981; ElWishy & Hemeida, 1984; Arthur *et al.*, 1985), but the number of these bodies in the ovaries of camels at a given age is usually higher than can be accounted for by the possible number of fetuses born, even bearing in mind the possibility of multiple corpora lutea of pregnancy. Whether this is related to frequent abortions (Arthur *et al.*, 1985), ovulation during pregnancy and/or follicular luteinization and regression during gestation is unknown.

References

Arthur, G.H., Noakes, D.E. & Pearson, H. (1982) *Veterinary Reproduction and Obstetrics*, 5th edn. Bailliere Tindall. London.

Arthur, G.H., A/Rahim, A.T. & Al Hindi, A.S. (1985) The camel in health and disease. 7. Reproduction and genital diseases of the camel. *Br. vet. J.* **141,** 650–659.

Banerjee, S.R., Vyas, K.K., Pareek, P.K., Deora, K.S. & Vyas, U.K. (1981) Note on the clinical diagnosis of early pregnancy in camel. *Indian J. Anim. Sci.* **51,** 909–910.

Barmintsev, Y.N. (1951) Rectal examination of the reproductive organs of the camel. *Konevod. Knaay* **21,** 38–42 (see *Vet. Bull.* **22,** 725, 1952).

Bhargava, K.K., Sharma, V.D. & Singh, M. (1963) A study of mortality rate, sex ratio and abortion in camel (*Camelus dromedarius*). *Indian J. vet. Sci.* **33,** 187–188.

Chen, B.V., Yuen, Z.X. & Pan, G.W. (1985) Semen-induced ovulation in the bactrian camel (*Camelus dromedarius*). *J. Reprod. Fert.* **75,** 335–339.

Elias, E., Bedrak, E. & Yagil, Y. (1984) Peripheral blood levels of progesterone in female camels during various reproductive stages. *Gen. comp. Endocr.* **53,** 235–240.

ElWishy, A.B. & ElSawaf, S.A. (1971) Functional activity of the ovaries and uterine horns in fat-tailed sheep and camels. *Fortpfl. Besam. Haustiere* **7,** 181–187.

ElWishy, A.B. & Hemeida, N.A. (1984) Observations on the ovaries of slaughtered camels (*Camelus dromedarius*). *Vet. med. J., Giza* **32,** 295–313.

ElWishy, A.B., Hemeida, N.A., Omar, M.A., Mobarak, A.M. & ElSayed, M.A.I. (1981) Functional changes in the pregnant camel with reference to fetal growth. *Br. vet. J.* **137,** 527–537.

Fernandez-Baca, S., Hansel, W. & Novoa, C. (1970) Corpus luteum function in the alpaca. *Biol. Reprod.* **3,** 252–261.

Ghoneim, I.M. (1985) *The ovary of the pregnant camel with special reference to the corpus luteum.* M.V.Sc. thesis, Cairo University.

Leese, S.A. (1927) *A Treatise on the One-humped Camel.* Haynes & Sons, Stamford.

Marie, M. & Anouassi, A. (1987) Induction of luteal activity and progesterone secretion in the non-pregnant one-humped camel (*Camelus dromedarius*). *J. Reprod. Fert.* **80,** 183–192.

Mobarak, A.M. & ElWishy, A.B. (1971) Uterus of the one-humped camel (Camelus dromedarius) with reference to rectal palpation. *Indian J. Anim. Sci.* **41,** 846–855.

Mugerwa, E.M. (1981) *The Camel* (Camelus dromedarius). *A Bibliographical Review.* ILCA Addis Ababa (Monograph No. 5, 147 pp), Addis Ababa.

Musa, B.E. & Abusineina, M.E. (1976) Some observations on reproduction in the female camel (*Camelus dromedarius*). *Acta vet. (Beograd)* **26,** 63–69.

Musa, B.E. & Abusineina, M.E. (1978a) The estrous cycle of the camel (*Camelus dromedarius*). *Vet. Rec.* **103,** 556–557.

Musa, B.E. & Abusineina, M.E. (1978b) Clinical pregnancy diagnosis in the camel and a comparison with bovine pregnancy. *Vet. Rec.* **102,** 7–10.

Perkins, J.E., Olds, D. & Seath, D.M. (1954) A study of 1000 Bovine Genitalia. *J. Dairy Sci.* **37,** 1158–1163.

Shalash, M.R. (1965) Some reproductive aspects in the female camel. *Wld Rev. Anim. Prod.* **4,** 103–108.

Received 12 June 1987