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THE USE OF ULTRASONOGRAPHY IN STUDYING THE FUNCTIONAL OVARIAN AND UTERINE CHANGES IN FEMALE DROMEDARY (Camelus dromedarius) IN UPPER EGYPT

(With 4 Tables and 4 Figures)

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استخدام الأشعة فوق الصوتية لدراسة التغيرات الوظيفية في المبيض والرحم في النوق وحيدة السنام في صعيد مصر

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استخدمت لهذه الدراسة ثلاث نياق وحيدة السنام على مدار ثمانية أشهر (من سبتمبر ٢٠٠٢ حتى أبريل ٢٠٠٣) بغرض التعرف على التغيرات التي تحدث في أرحام ومبايض هذه الحيوانات باستخدام الأشعة فوق الصوتية. أظهرت نتائج هذه الدراسة أن النشاط المبيضى والذي بدأ في شهر نوفمبر ظهر في صورة موجات متتابعة من النمو الجريبي توزعت بالتساوي تقريبا بين كلا المبيضين الأيمن والأيسر. أمكن تحديد أربع مراحل للنمو الجريبي أثناء الدورة التناسلية وهى مراحل النمو ثم مرحلة النضج والسيادة ثم مرحلة الرتق ويعقبها مرحلة من السكون قبل الدخول في مرحلة النمو مرة أخرى دون راحة. تميزت الدورة التناسلية بوجود موجتين متتاليتين من النمو الجريبي. الموجة الأولى استغرقت ٨-٢٣ يـوم (١٣,٨١ ± ٠,١٤ يوم) وتميزت بنمو ٤-٧ جريبات صغيرة (٤,٩٤ ± ٠,٢٤). واحدة من هذه الجريبات والتي تدعى الجريبة السائدة استمرت في النمو حتى وصلت إلى ١٤,١١ – ١٨,٤٣ مم (١٦,٣٢ ± ٠,٥٦ مم) كحد أقصى قبل أن تبدأ في الرتق. لم يلاحظ أي أهمية تشخيصية للتغيرات التي حدثت في الرحم باستخدام جهاز الأشعة فوق الصوتية خلال هذه الدراسة. من ناحية أخرى لم يكن هناك أي تأثير للفترة الزمنية على قطر الجريبة أثناء فترة النشاط المبيضي. بالنظر إلى النتائج التي تم الحصول عليها يمكن القول بأن دورة الشبق في الجمال ليست كمثيلاتها في باقي أنواع الثدييات من حيث المسمى والمضمون إذ أنها عبارة عن مجموعة من الموجات الجريبية النامية التي تظهر النشاط المبيضى في هذه الحيوانات والتي أبدا ما تتعرض للتبويض إذا لم تلقح هذه الحيوانات. بالإضافة إلى أن استخدام الأشعة فوق الصوتية على درجة كبيرة من الأهمية لمتابعة التغيرات التناسلية في النوق.

SUMMARY

In order to monitor the ovarian and uterine echographic changes in the female camel during the ovarian activity, three dromedary heifers aged 4-5 years were assigned for this study. The animals were examined transrectally every third day prior to the breeding season and each second day after the commencement of ovarian activity using a pie medical 6-8 MHz scanner. Results of this study showed. that follicular activities continued with overlapping follicular waves. Barley, ovarian activities were distributed equally in both ovaries. Prior to the breeding season, growth of many small follicles (<10 mm) was observed but the size of these follicles never exceeded 10 mm throughout the studied period and were subjected to atresia. The beginning of the ovarian activity (breeding season) was marked by the appearance of a follicle more than 10 mm at the time of clinical examination (rectal and ultrasonographic). Four phases of follicular development were observed during each follicular cycle including phase or stage of follicular recruitment and growth of follicles, stage of follicular selection and dominance, follicular regression and finally stage of quiescence. Two follicular waves were identified per follicular cycle. The first (incomplete) follicular wave lasted 8-23 days (13.81 ± 0.14) and characterized by the development of 4-7 small follicles (4.94 ± 0.24). One of these follicles grew up to reach a maximum size of 14.11-18.43 (16.32 ± 0.56) mm then started to regress gradually. The second (complete) follicular wave lasted for 11-34 (18.84 ± 2.18) days and characterized by the development of a dominant follicle of maximum preovulatory size (19.20-38.14 average of 27.42 ± 0.64 mm). The whole follicular cycle lasted 19-42 days (average 31± 5.36 days). During the period of ovarian activities, no major changes in the uterine echotexture were observed hence its diagnostic value for estimating the stage of the follicular wave was minor. It was concluded that the follicular cycle in the camel is overlapping with continuous follicular development and regression. Ultrasonography is of a great help for the management of breeding especially when efficiently used in camelids reproduction to monitor the follicular changes and determine the proper time for breeding.

Key words: *Ultrasonography, Ovarian & Uterine Changes, Female dromedary, camelus dromedaries.*

INTRODUCTION

Understanding the emergence and development of a follicular wave is very important for many reproductive procedures such as determining the optimum time for breeding. The dromedary camel is a seasonally induced ovulator with the follicular waves instead of the estrous cycle during the breeding season. In addition, the seminal plasma is necessary for ovulation and functional corpus luteum formation (Cooper *et al.*, 1992 and Arthur, 1993). In fact, definition of the estrous cycle in camelidae is very complicated and it is not surprising that there are large discrepancies in the literature concerning its length. In the absence of ovulation, the ovarian activity is limited to a succession of regular follicular variations called follicular waves (Abdel-Raouf, 1993). Each follicular wave can be divided into 4 distinct phases follicular recruitment phase, follicular growth and establishment of dominance, follicular maturity and follicular regression (Skidmore et. al. 1996). The duration of each phase of these phases of the follicular cycle in non bred females is very variable (Arthur *et al.* 1996). The final size of the mature preovulatory follicle during the stagnation period is quite variable. Tibary and Anouassi (1996) mentioned that follicles can ovulate when they reach a minimum of 10 mm in diameter. Dominant follicles in a particular female can grow as much as 2 mm per day to reach 25 mm in diameter.

The primary objective of the present study is to characterize the events of the follicular wave in the dromedary She-camel in Upper Egypt. Ultrasonographic features of the ovary and uterus during the follicular wave were also recorded.

MATERIALS and METHODS

The animals:

Three healthy and reproductively sound dromedary heifers aged between 4-5 years and weighed about 400-500 kg were used in this investigation. The camels were housed in an opened shed at the Veterinary teaching clinic, Faculty of Vet. Med., Assiut Univ. During the examination, the animals were secured and restrained for ultrasonographic gynecological examination (using Pie Medical Scanner 100 LC, Pie Medical Co., Netherlands).

Experimental design:

The study was designed to characterize the ovarian and uterine changes during the studied period in absence of mating and subsequent

ovulation. The study extended for over a period of 8 months (from September till April 2002/2003). Before the beginning of the reproductive activity (breeding season), the animals were examined each third day. Following the commencement of ovarian activity, they were examined each second day. Ultrasonography was done in the manner described for dromedary camels by Tibary and Anouassi (1996). The equipment used was a real time, B-mode scanner fitted with 6-8 MHz linear probe. Briefly, after removal of fecal material, the probe was introduced manually into the rectum using lubricant. The genital tract was scanned slowly over all its parts starting with the cervix, then each uterine horn was followed by the ipsilateral ovary.

Parameters recorded following ultrasonographic examination were the echotexture of the uterus and the ovarian structures. All ovarian structures were measured to the nearest millimeter using the ultrasound built in measuring ruler. Ovarian follicles were categorized into: small (less than 10 mm), medium (10-15 mm) and large (more than 15 mm). The length of each stage of the follicular wave was also considered.

Statistical analysis:

Statistical analyses of the collected data were carried out according to procedures of completely random design, SAS (1995).

RESULTS

Follicular dynamics

During the non breeding season (Sep.-Nov.)

This period was characterized by the growth of many small follicles (<10 mm) but the size of these follicles never exceeded 10 mm throughout the studied period and subjected to atresia. No major events took place during this period. The growth of small follicles took about 4-8 days (average 6.24 ± 0.52) and remained for 4-12 days (average 9.21 ± 1.06) before final regression (Fig. 1).

During the period of ovarian activity (Nov.-April)

Ovarian activity commenced during the second half of November. The beginning of the ovarian activity (breeding season) was marked by the appearance of the first follicle with a diameter more than 10 mm during the time of ultrasonic examination. The results obtained by serial examinations of the she-camels showed a great variation in the follicular dynamics. Thirteen follicular cycles (each included two follicular waves) were marked throughout the studied period (5, 3 and 5 cycles for animals I, II and III, respectively). In general, two

distinguished follicular waves with variable durations were observed (Table 1). The whole follicular cycle lasted 19-42 days (average 31± 5.36 days). Three (in the first incomplete wave) or four (in the second complete wave) phases of follicular development were noticed during each follicular cycle including phase or stage of follicular recruitment and growth, follicular selection and dominance, follicular regression and stage of quiescence. The first (incomplete) follicular wave was short, lasted 8-23 days (13.81 ± 0.14) and characterized by the development of 4-7 small follicles (4.94 ± 0.24). One of these follicles grew up to reach a maximum size of 14.11-18.43 (16.32 ± 0.56) mm then started to regress gradually. During the time of regression of this follicle, the contra-lateral ovary started a second [complete one lasted 11-34 days (18.84 ± 2.18)] follicular wave which continued in the same fashion but the dominant follicle reached a size of 19.20-38.14 mm with average of 27.42 ± 0.64 mm (Table 2) and lasted for 3-9 (6.42 ± 1.28) days. Regression of the dominant follicle lasted 3-9 days (7.23 ± 1.97). There was no significant difference between number of small, medium or large follicles on the right or left ovaries. A period of quiescence lasted for 3-6 (4.11 ± 0.86) days was followed before the start of a new follicular cycle. Follicular waves were distributed alternatively and nearly even between right and left ovaries as in Table (3).

Table 1: Parameters of the different phases of the 1st and 2nd follicular waves in she-camels.

Wave	Duration (days)	Fol. growth phase (days)	Fol. maturation. Phase (days)	Fol. atresia phase (days)	Quiescence phase (days)
1st	8-23 (13.81±0.14)	3-6 (4.24±0.93)	3-6 (4.66 ± 0.88)	3-6 (4.91± 22)	00.00
2nd	11-34 (18.84±2.18)	3-6 (5.01±0.46)	3-9 (6.42±1.28)	3-9 (7.23±1.97)	3-6 (4.11±0.86)

Table 2: Size (mm) of the dominant and subordinate follicles dynamics during the 1st and 2nd follicular wave of the she-camel.

Fol. Wave	Dominant follicle (mm)	Subordinate follicle (mm)
1st wave	14.11-18.43 (16.32 ± 0.56)[a]	5.13-3.89 (4.33 ± 0.05)[a]
2nd wave	19.20-38.14 (27.42 ± 0.64)[a]	8.74-15.31(10.13 ± 0.32)[a]

Figures in the same row with different superscripts differ significantly ($p<0.01$)

Table 3: Distribution of different sized follicles in the right and left ovaries

Ovary	Number of small follicle (<10 mm)	Number of medium follicle (10-15 mm)	Number of large follicle (>15mm)	Distribution of dominance
Right	5.21 ± 0.22	0.97 ± 0.21	0.93 ± 0.08	52%
Left	4.32 ± 0.01	0.92 ± 0.09	1.03 ± 0.04	48%

Diameter of the largest follicle was not affected by the month of the year while diameter of the second largest follicle was significantly ($p<0.01$) affected. Diameter of the second largest follicle increased significantly during March and April. Number of small, medium and large follicles increased significantly during the period from February till April as shown in Table (4).

Table 4: Effect of the month of the year during the breeding season of female dromedary camel on the diameter of the largest (Lfd) and second largest follicles (Sfd), number of large (LF, > 15 mm), medium (MF, 10-15 mm) and small (SF, <10 mm)follicles.

Month	Diameter (mm)		Number		
	Lfd	Sfd	LF (>15 mm)	MF (10-15 mm)	SF(<10 mm)
November	0.57 ± 0.15^{a}	0.26 ± 0.09^{a}	0.00^{a}	0.33 ± 0.20^{a}	17.53 ± 1.63^{a}
December	0.53 ± 0.12^{a}	0.29 ± 0.08^{a}	0.00^{a}	0.23 ± 0.17^{a}	16.19 ± 1.37^{ab}
January	0.63 ± 0.15^{a}	0.27 ± 0.09^{a}	0.33 ± 0.14^{b}	0.60 ± 0.20^{a}	14.86 ± 1.63^{ab}
February	0.63 ± 0.12^{a}	0.28 ± 0.07^{a}	0.33 ± 0.11^{b}	0.83 ± 0.15^{b}	13.45 ± 1.28^{ab}
March	1.41 ± 0.12^{a}	0.72 ± 0.07^{b}	0.29 ± 0.11^{b}	1.04 ± 0.10^{b}	13.20 ± 1.28^{ab}
April	1.43 ± 0.07^{a}	0.84 ± 0.04^{b}	0.22 ± 0.07^{b}	0.82 ± 0.10^{b}	11.73 ± 0.83^{b}

Figures in the same row with different superscripts differ significantly ($p<0.01$).

Ultrasonographic findings:

Ovarian findings:

The ovary in the studied animals was monitored easily lateral to the uterine body. The right ovary was located just cranial to the urinary bladder, which is considered as the main guide for the genital organs ultrasonically. The left ovary was located most cranial to the left uterine

horn. In some instances, the fallopian tube was monitored clearly surrounding the ovary (Fig. 1). The recruitment and growth phase of the follicle was characterized by the presence of multiple small follicles arranged at the periphery of the ovary. The selection of the dominant follicle was followed by a phase of growth averaging an increase in diameter of 4.2 ± 0.05 mm each second day. The follicle continued to grow at this rate until they reached a maximum diameter of 19.20-38.14 (27.42 ± 0.64) mm within 3-5 days (4.12 ± 0.54). The mature follicle is a thin walled well defined fluid-filled structure (Fig. 2). During the regression period, the follicular fluid of these follicles, became more echogenic owing to the development of free floating echogenic strands which later becomes more organized into transecting strands of fibrin. With regard to the ultrasonic appearance of the atretic follicles, five ultrasonic models of atretic follicles were identified (Fig. 3):

1. Thin-walled, large follicular structure containing clear fluid.
2. Thick-walled (2 - 4 mm) structure containing clear fluid.
3. Thick-walled structure with some floating debris within its cavity.
4. Thick-walled structure with blood clot and fibrin strands within the cavity (hemorrhagic follicle).
5. Luteinized like-structure.

The uterine echotexture

During the ovarian activity and subsequent follicular growth, no major changes in the uterine echotexture was observed (Fig. 4). Slight oedema was found during the presence of large dominant follicle on the ovary. However, rectal examination was more useful in this regard. Turgidity of the two uterine horns increased significantly during the dominance time and gradually lost with the atresia of the dominant follicle.

DISCUSSION

The ovarian activity of the studied animals started in November in accordance with previous reports in camels (Musa and Abusineina, 1978, Joshi *et al.*, 1978, Marzook *et al.*, 1993, Tibary and Anouassi, 1996) and in llamas (Brown, 2000). Follicular activity in she camel is suppressed during the months of late summer and early autumn (Musa and Abusineina, 1978). As day length decreases, the average number and diameter of follicles increase over 2 to 3 months (transitional period). During the transitional period, follicles grow and regress sequentially. Month of the year had no effect on the diameter of the largest follicle

during the follicular wave. However, the number of the different sized follicles increased significantly by the time of the year. This is coincident with previous reports on reproduction in Dromedary camel (Musa, 1969, Musa and Abusineina, 1978, Novoa, 1970, Mukasa, 1981, Minoia *et al.*, 1993 and Tibary and Anouassi, 1999) and llamas (Bravo *et al.*, 1990). Most investigators have concluded that waves of follicular growth, maturation and atresia occurred throughout the breeding season in she camel but the time-course of such events can vary with latitude, stage of the season, age and nutritional status of the camels (El-Wishy, 1988).

Our results on the follicular wave presented great similarities with those found in the llamas and alpacas (Adams *et al.*, 1990 and Bravo *et al.*, 1990)) and camels (Skidmore *et al.*, 1995). In the llama, follicular activity was present in one or both ovaries at all times, with waves of development and regression overlapping in the same opposite ovaries. A short follicular wave occurred in which ovulatory size was not attained. All the ultrasonographic features of the uterus during the follicular wave in the camel in this study were similar to those described for the llama (Adams *et al.*, 1989 and Bravo et. al., 1990). This included a typical peripheral arrangement of the growing follicles, a protrusion and ease of palpation of the mature follicle and a distinct difference in echotexture between the periphery of the ovary and the ovarian medulla (more echogenic area). The maximum diameter reached by the dominant follicle before regression was 19.20-38.14 (27.42 ± 0.64) mm which was similar to values reported for the size of the mature follicle in camel (Skidmore et. al., 1995 &1996 and Tibary and Anouassi, 1996).

By repeated rectal palpation of the genital organ during the breeding season, Musa and Abusineina (1978) found that a period of about 6 days was required for a developing follicle to reach its full size (1.5-3 cm, but occasionally up to 10 cm) which was obtained in an average of 13 days and then follicular regression occurred during the following 8 days where another follicle began to develop in the other ovary. Skidmore *et al.* (1996) divided the follicular cycle into a growth phase (10.5 ± 0.5 days), a mature phase (7.6 ± 0.8 days) and a regression phase (11.9 ± 0.8 days). For convenience, the pattern of change in the follicular growth has been described in three stages; growth, maturation and regression or atresia (Novoa, 1970, Arthur *et al.*, 1985 and Brown, 2000). In a detailed study, Tibary and Anouassi (1996) found that follicular activity in the dromedary camel were divided into two types : incomplete waves characterized by the emergence of 1 to 3 follicles on

the ovary then regressed without giving rise to a mature follicle. Complete follicular waves with 4 phase of development include quiescence, recruitment, growth and dominance and finally follicular regression.

The length of the follicular wave (first or second wave) reported here were in agreement with previous reports of Nawito *et al.* (1967) and Marzook *et al.* (1993) in unmated camels in which the length of estrus cycles ranged from 11 to 35 days. Female camels are seasonal breeders with a relatively short breeding period during which ovarian activity is increased (Novoa, 1970). They are also 'induced ovulators' and therefore they normally ovulate only in response to mating (Musa, 1969 and El-Wishy, 1988). In these animals the neuro-endocrine reflex involving initiation of the release of LH from the pituitary gland delays until coitus occurs. For this reason follicles tend to grow, have a period of maturity during which time they are capable of being ovulated, and then regress again if ovulation is not induced (El-Wishy, 1988). It is therefore more accurate to describe the changes in the ovarian follicular dynamics as a 'follicular wave pattern' rather than an oestrous cycle. Earlier studies on the follicular wave pattern in dromedaries were based on post slaughter examinations and on serial palpations of the ovaries per rectum in small numbers of camels. Results of previous studies reported that the duration of the follicular wave ranged from 17 - 23 days in India (Joshi *et al.*, 1978), 24 days in Egypt (Nawito *et al.*, 1967) and 28 days in the Sudan (Musa and Abusineina, 1978) but they tend to be longer at the beginning and end of the season (19 - 22 days) than during the middle of the season (12 - 15 days).

The non follicular (or follicular recruitment) phase is the time lapse between an examination which does not show any follicular activity, and the emergence of several follicles (2 - 3 mm) on the surface of the ovary (Skidmore, 2000). Not much is known about the mechanisms of recruitment of each follicular wave but it is possible that it constitutes a response to an increase in FSH, however, it can only be thoroughly investigated by histological techniques. In the dromedary, this follicular recruitment phase takes between 2 - 4 days (Skidmore, 2000). The period of follicular recruitment is followed by a period of follicular growth of 3 - 6 follicles until the establishment of one or two dominant follicles. In the dromedary, these follicles can grow at a rate of about 0.5 - 1.0 mm per day until they reach approximately 1.0 cm in diameter and then one or two follicles become dominant and continue to grow. This growth phase generally lasts between 6 - 10 days (Skidmore

et al., 1995). In about 50% of the cases examined by Skidmore (2000), the dominant follicle grew to a mean maximum diameter of 2.0 ± 0.1 cm (range 1.5 - 2.5 cm) whilst the others regressed, whereas in the other 50% of the cases the dominant follicle continued to grow to a mean maximum diameter of 4.2 ± 0.2 cm (range 4.0-6.4 cm) before it started to regress, taking on average 18.4 ± 0.8 days to reach its maximum diameter. There is a strong relationship between the number of follicles present and the diameter of the largest follicle, which is consistent with the follicle wave theory (Skidmore *et al.*, 1995 and Tibary and Anouassi, 1996).

Similar to the present findings, Skidmore *et al.* (1995) reported that follicular maturation phase encompasses the time when the follicle has reached maximum diameter and is capable of ovulating. The establishment of dominance and the regression of subordinate follicles is likely to be under the control of in-situ production of inhibin by the follicle. This is supported by the increased number of follicles from the same wave reaching sizes greater than 1.0 cm after immunization of the dromedary female against inhibin (Skidmore, 2000).

In the absence of mating or ovulation-inducing treatment, Tibary and Anouassi (1996) and Skidmore (2000) claimed that the mature follicle starts to regress, taking an average of 11.9 ± 0.8 days if the mature follicle measures 1.5-2.5 cm, and 15.3 ± 1.1 days for the larger anovulatory follicles. These follicles do not inhibit the growth of other follicles in the same, or contra-lateral ovary, which mature and ovulate if the appropriate stimulus is applied (Skidmore *et al.*, 1995 and Tibary and Anouassi, 1996).

The fate of the non-ovulating follicles remains one of the most interesting feature of the camel follicular cycle. The evolution of the dominant follicle in the absence of mating presents two possible outcome: regression or a cystic degeneration in the form of an anovulatory follicle. Cystic follicle condition was described in llamas and alpacas (Bravo *et al.*, 1990). In general for these species, follicles larger than 12 mm in diameter in alpacas were considered pathological cysts (Adams *et al.*, 1989). These cysts lasted on the average 9.3 days (range 4 to 21.9 days). Similar conditions were described in the one-humped camel (Tibary and Anouassi, 1996). According to the present observations, these cysts are probably just anovulatory follicles emerging form the dominant follicles in absence of ovulation stimulus. Anovulatory follicles were also described as haemorrhagic follicles in the llama (Adams *et al.*, 1990).

The left and right ovaries function equally and ovulate alternately (Skidmore, 2000). Because ovulation is induced by coitus the length of estrus depends on whether or not mating occurs. In the absence of a male, estrus may last about 2 weeks, whereas if copulation occurs on the first day of estrus, receptivity may disappear after 3 days (Arthur, 1993, Arthur *et al.* 1996). The distribution of follicular activity (emergence of large follicles) was found to be equally distributed between ovaries in the llamas (Bravo *et al.*, 1990). However in the camel, it was reported that the left ovary was more active than the right ovary (El Wishy, 1988 Skidmore 2000). From the present study we did not see any significant difference in the follicular activity between the left and right ovary. Similar results were obtained in the dromedary by Tibary and Anouassi (1996). However, Marzook *et al.* (1993) mentioned that almost all conceptuses are located in the left uterine horn. This high incidence of left horn pregnancies is attributed to migration of the fertilized ovum from the right to left horn when the right ovary ovulates.

In the present study, manual palpation of the uterus was, clinically, more diagnostic than the echogenic appearance of this organ. The uterus was found contracted and turgid during the maturation and dominant follicular phase. Turgidity and contractility of the uterus was lost after the follicular regression. Similar findings were described by Marzook *et al.* (1993) and Tibary and Anouassi (1996). The pattern of uterine activity was correlated with the circulating levels of estradiol-17β (Marzook et. al., 1993). It was concluded in these previous studies that uterine activity in the camel is dependent on estrogen level.

CONCLUSION

In conclusion, it is obvious that, follicular activities in the dromedary female were presented in a continuous fashion and overlapping follicular cycles. Maximum size of the dominant follicle was 14.11-18.43 (16.32 ± 0.56) mm during the first follicular wave of the follicular cycle and 19.20-38.14 (27.42 ± 0.64) mm during the second main follicular wave. The fate of the dominant follicle in non mated dromedary female was one of five possibilities; 1) thin-walled, large follicular structure containing clear fluid; 2) thick-walled (2 - 4 mm) structure containing clear fluid; 3) thick-walled structure with some floating debris within its cavity; 4) thick-walled structure with blood clot and fibrin strands within the cavity (hemorrhagic follicle) or 5) luteinized follicle. Ultrasonography is of a great help to identify the

stage of the follicular wave in dromedary female and could be used to determine the proper time for breeding.

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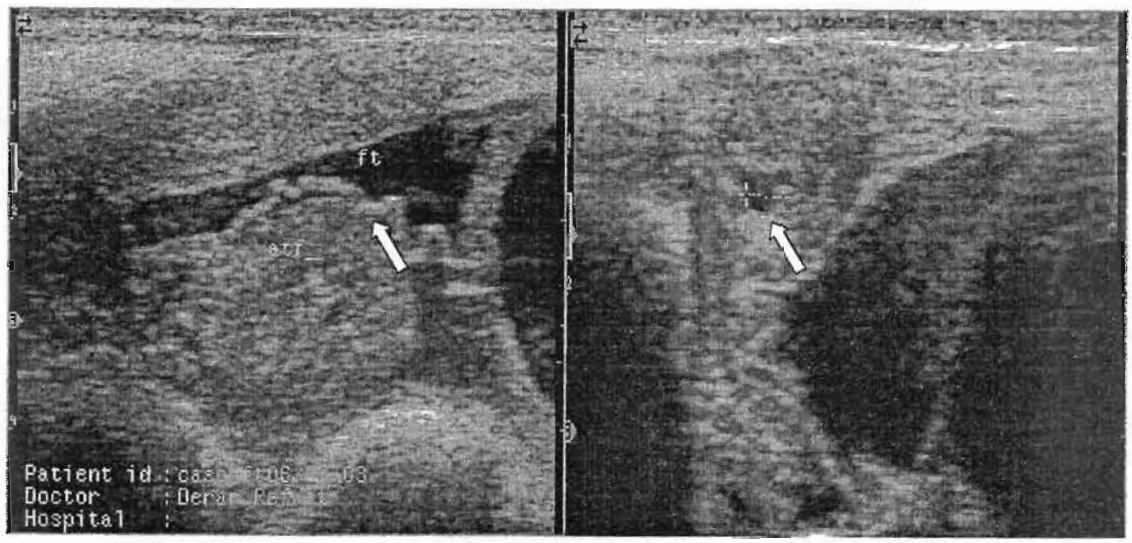

Fig. 1: Ultrasonographic appearance of the ovaries during the non breeding season in she-camel. Note only small follicles (less than 10 mm) could be seen (white arrow). In the left side of the above figure, the fallopian tube (arrow) is surrounding the ovary.

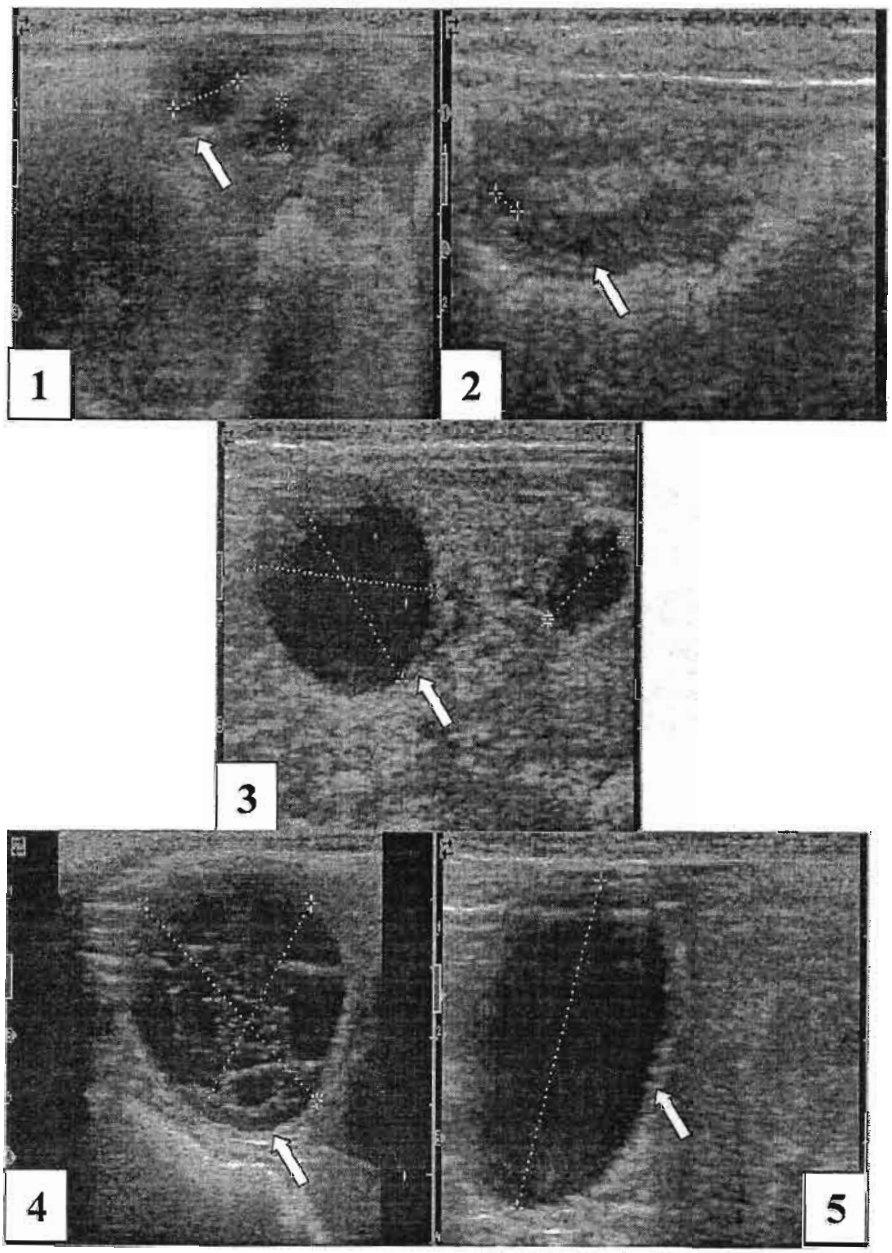

Fig. 2: Ultrasonographic appearance of different developmental phases of the follicular wave (white arrows), in she-camel. It started starting from the follicular recruitment phase (1), follicular growth (2), follicular maturation (3), follicular dominance (4) and atresia (5) as recorded ultrasonically.

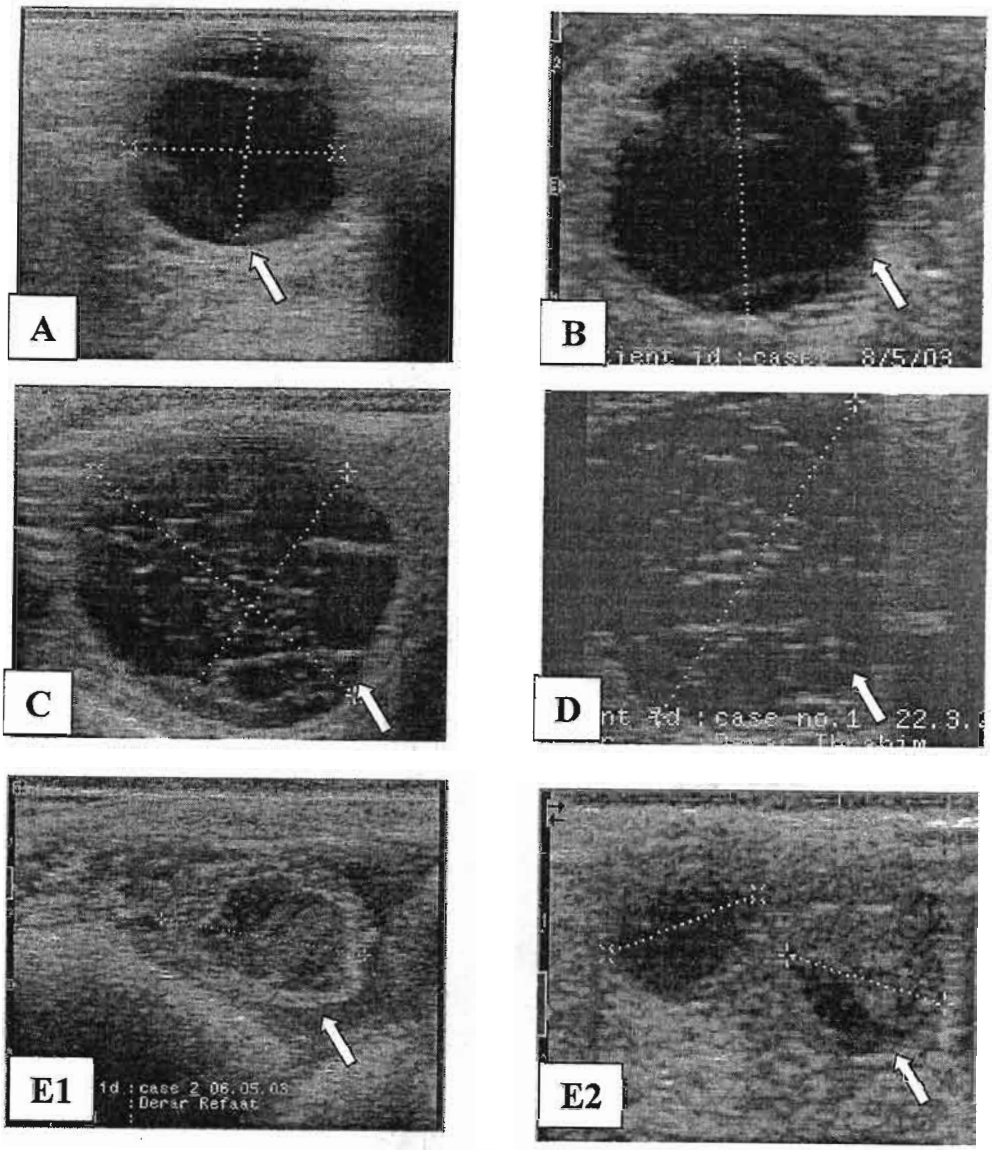

Fig. 3: Different ultrasonographic appearance of follicular atresia in the camel during the normal follicular cycle.

A- thin-walled atretic follicle with clear follicular fluid.

B- thick-walled-follicle with clear follicular fluid inside.

C- thick-walled-follicle with echogenic particles inside the follicular antrum.

D- thick-walled-follicle with network of echogenic threads (fibrin).

E1 and E2- Luteinized-like structure.

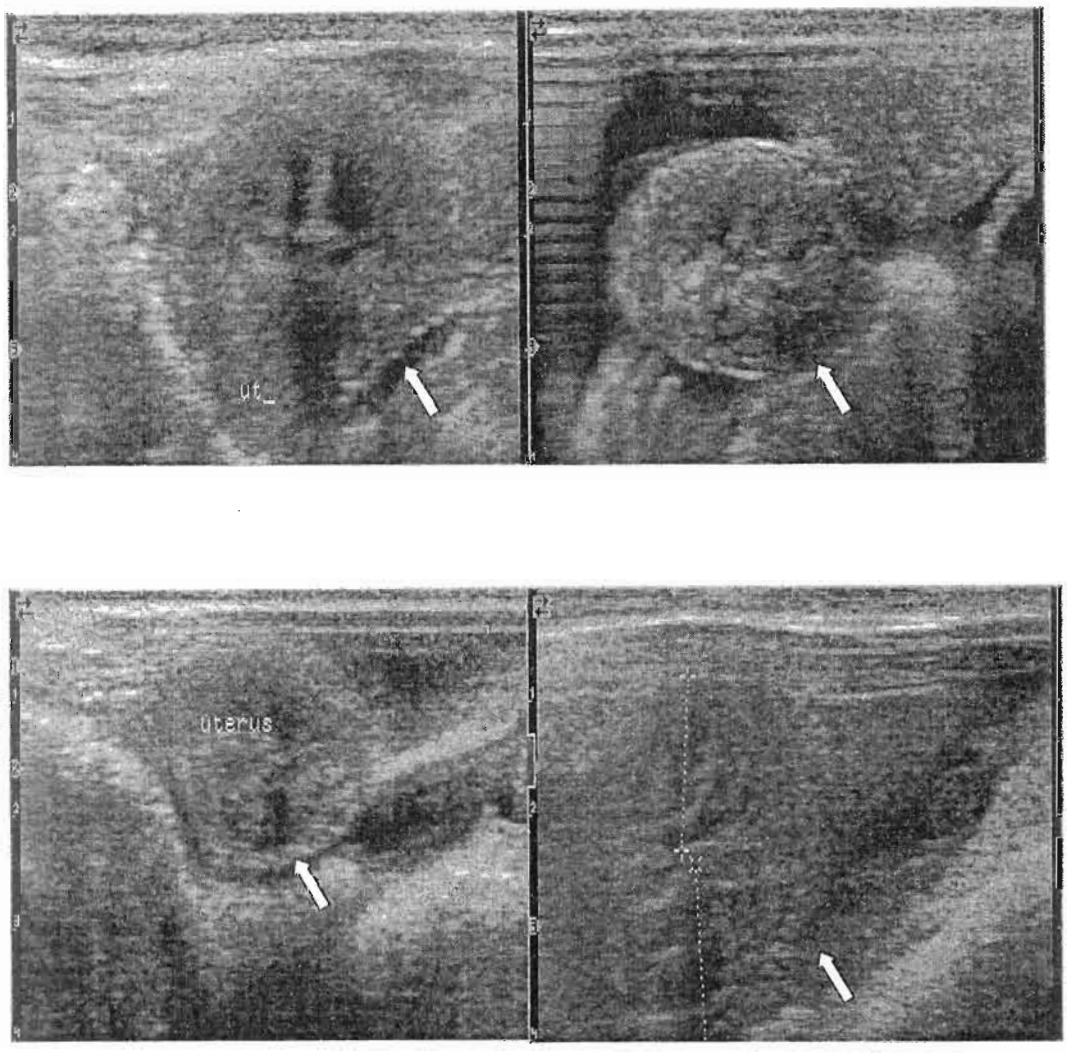

Fig. 4: Ultrasonographic appearance of the uterus of she-camel during the follicular cycle (n= 3), however, no caracteristic changes took place during the different phases of the cycle (white arrows pointed out to the left uterine horn).