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ULTRASONOGRAPHIC IMAGES OF THE CLINICALLY NORMAL MAMMARY GLAND IN ONE- HUMPED CAMELS (*CAMELUS DROMEDARIES*)

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SUMMARY

The ultrasonographic images of clinically normal mammary glands of fourteen one-humped she-camels were recorded using 5.0 and 7.5 MHz linear transducer. The obtained results were confirmed through dissection of three mammary gland samples obtained freshly from the slaughterhouse. The glandular parenchyma of the udder of non-lactating she-camels appeared uniformly hyperechoic than that of the lactating one. At the base of each quarter two distinct gland cisterns were seen shared, a common hyperechoic wall while the cistern cavity appeared anechoic because of presence of milk. The teat wall was differentiated into four ultrasonographic layers. Each teat possessed two separate anechoic teat cistern separated with a hyperechoic connective tissue band and communicated with the outside of the teat with a separate streak canal, which appeared as a thin, hyperechoic line. We can conclude that ultrasonographic imaging of the mammary gland in one-humped camels is a noninvasive imaging technique which can be performed in both standing and recumbent positions. The teats of one-humped she camel's possess only two cisterns and two separate streak canals like other Camelidae species. Moreover, the normal ultrasonographic pattern of the mammary gland will be helpful for further studies dealing with diagnosis of different mammary gland diseased conditions.

Keywords: Mammary glands, Ultrasonographic images, Camels (Camelus dromedaries).

side area (8 animals). The mammary glands were clinically examined and milked prior to the ultrasonpgraphic examination for exclusion of any diseased conditions. The examination was carried out by using a portable scanner 480 ultrasonographic machine (Pie medical Netherland) equipped with a 5 to 7.5 MHz, 60 mm linear array probe. Ultra gel (Medilap Company, Egypt) was used as a contact gel.

All examined camels were sedated using 2% xylazine Hcl (Xyla Ject ADWIA, Egypt) in a dose of 1.25 mg/kg body weight. Ten animals were examined in the standing position while the rest of animals were examined in the recumbent position. The body of the forequarters was examined using an anterior and lateral approaches and the body of the rear-quarters was examined using a posterior and lateral approaches. Each quarter was examined at three positions in both vertical and horizontal cross sections; at the base, in the middle, and proximal to the gland cistern. The distal part of the gland cistern, the teat cistern and the teat canal were examined in sagittal and cross sections. To optimize images of the teat in the probe and the examined teat were submerged in water in a rubber glove held by an assistant. Static ultrasonographic images of the mammary gland and teats of each animal were recorded on black and white video prints using a Sony video printer (Sony Inc, Tokyo, Japan).

Glandular parenchyma was evaluated for its echogenic characteristics and homogeneity. The boundary between the gland cisterns within the quarter and the connection between each gland cistern and the corresponding teat cistern were assessed ultrasonographically. The teats were examined for the number of the teat cisterns, streak canals and the distinctness of demarcation between the teat wall layers.

Gross anatomical examination was performed on three apparently normal mammary glands brought freshly from the slaughterhouse.

RESULTS

The results of ultrasonographic examination of the mammary gland of 12 adult she-camels are illustrated in table (1). The glandular parenchyma of the mammary gland in non-lactating she-camels appeared uniformally hyperechoic than that of the lactating one (F ig 1 a & b). In case of lactating she-camels, the milk in the collecting system appeared anechoic. The collecting system was seen extended from smaller ducts in the periphery of the gland through progressively larger ducts as the milk approaches the large gland cistern (Fig. 2 c&d).

INTRODUCTION

Unlike other ruminant species ultraosonographic imaging of the camel udder is somewhat neglected. Ultrasonic examination of the mammary gland had been described for bovine by Cartee, et al. (1986); Takeda, (1989); Trostle and O'Brien, (1998); for goats by Bruckmaier and Blum, (1992); for sheep by Roberte, et. al. (1994); Ahmed, (2001); Franz, et al. (2003).

The udder of the camel consists of four glandular quarters, each with its own teat (Nosier, 1974). The left and right halves of the udder are separated from each other by fibroelastic tissue extending from the linea alba and prepubic tendon and a groove generally visible between the left and right halves. The lateral aspect of the quarters is covered by tissue from the abdominal tunic and the caudal abdominal wall. The anterior and posterior quarters are independent but there is no visible separation between them and the teats are directed cranio-ventrally possessing two opening (Smuts and Bezuidenhout, 1987). In one-humped camel, both fore and hind teats are almost equal in length while the fore-teats are placed further apart from each other than the hind ones (Saleh, et al. 1971).

Contrast radiography on South American Camelidae has shown that each quarter is composed of two distinct glands each leading to a separate streak canal within the respective teat. The udder is therefore, composed of eight separate glands (Fowler, 1998). The radiographic examination of the teats in one-humped camel reveals that each teat possesses two to three teat cisterns. Each cistern is spindle-shaped, tapers distally and possess into the streak canal. The streak canals open independently into a small, common pouch at the apex, but sometimes the streak canals open directly on the surface of the apex of the teat (Saleh, et al. 1971).

The present study was undertaken to elucidate the using of ultrasound as a non-invasive tool for the mammary gland examination and to throw the light on the reference ultrasonographic images of the clinically normal mammary gland in one-humped camels (*Camelus dromedaries*).

MATERIALS AND METHODS

Ultrasonographic examination of the udders of 14 apparently healthy she- camels of different ages (4 to 8 years old) were performed at Faculty of Veterinary Medicine; Sadat City teaching farm (6 animals) and in the country

Table 1: Overall results of the ultrasonographic examination of clinically normal mammary glands of 14 she-camels

		Non -Lactating	Lactating
Total animals number		6	8
Glandular tissue			
	hypoechogenic	2	7
	hyperechogenic	4	1
	homogenousc	6	8
Lactiferous ducts			
	visible	1	8
	Non visible	5	....
Gland cistern			
	visible	6	8
	Non visible	....	...
Teat cistern			
	visible	6	8
	Non visible	....	...
	Two in nunber	6	8
Teat wall			
	Identified 4 layers	4	8
	Non identified	2	...
Streak canal			
	visible	1	8
	Non visible	5	...

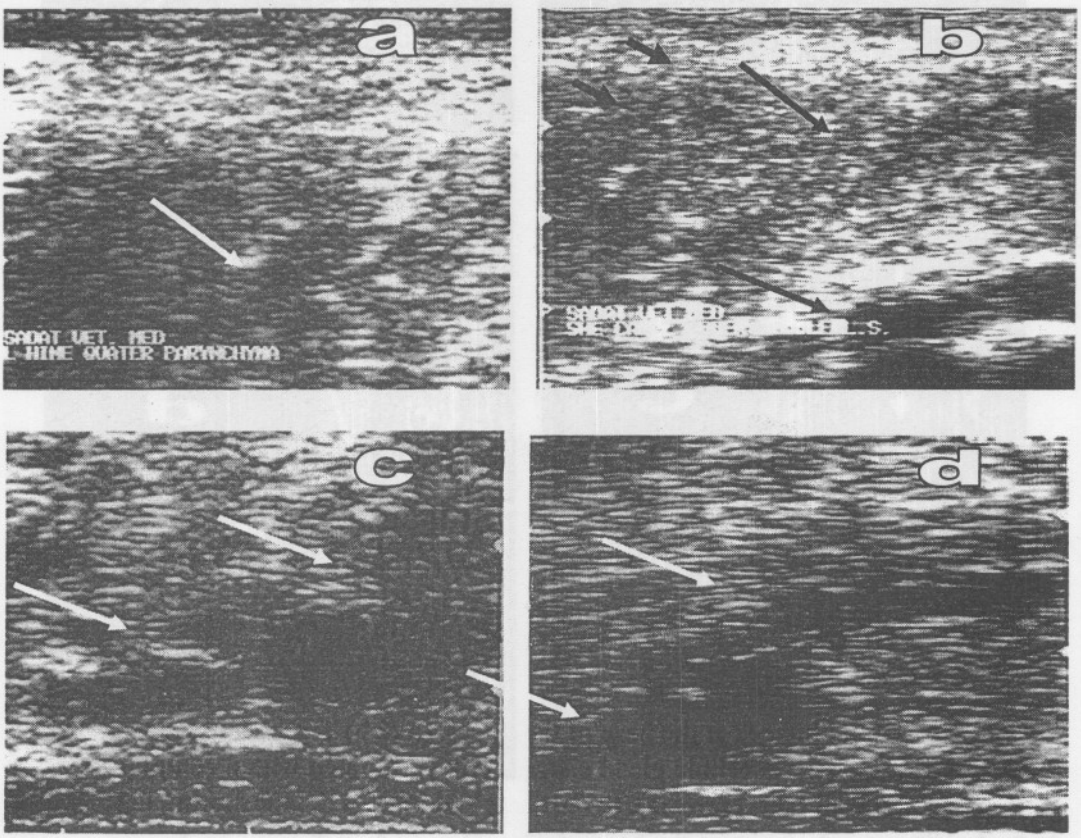

Fig. 1- Sonograms of a glandular parenchyma (a & b) non-lactating she-camels with a uniform hyperechogenic appearance obtained with a 5 MHz. (c & d) lactating she-camels with a medium homogenous echogenicity obtained with a 7.5 MHz. The lactiferous ducts (long arrows) and vessels (short arrows) appear as anechoic areas. Skin is on the top of the picture.

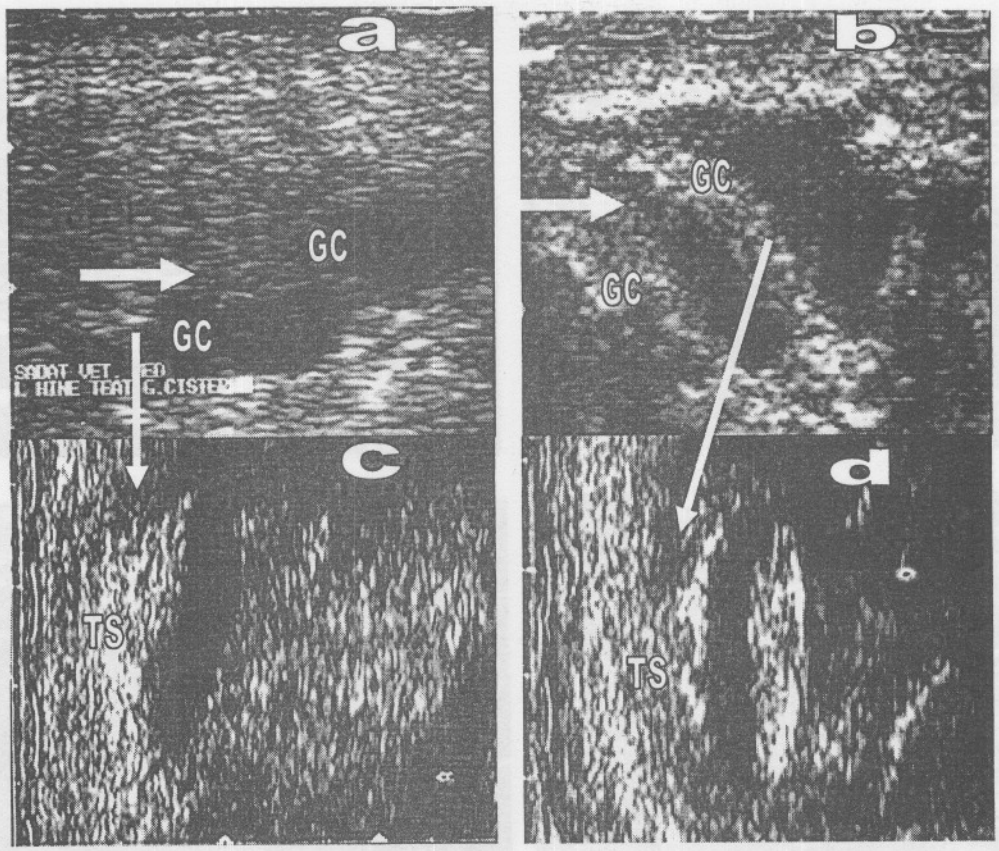

Fig. 2- Ultrasound images at the base of the udder. (a & b) Transverse images demonstrating two anechoic gland cisterns (GC) separated with a common hyperechoic wall (short arrows). (c &d) Sagittal images demonstrating the anechoic teat cistern (TS).

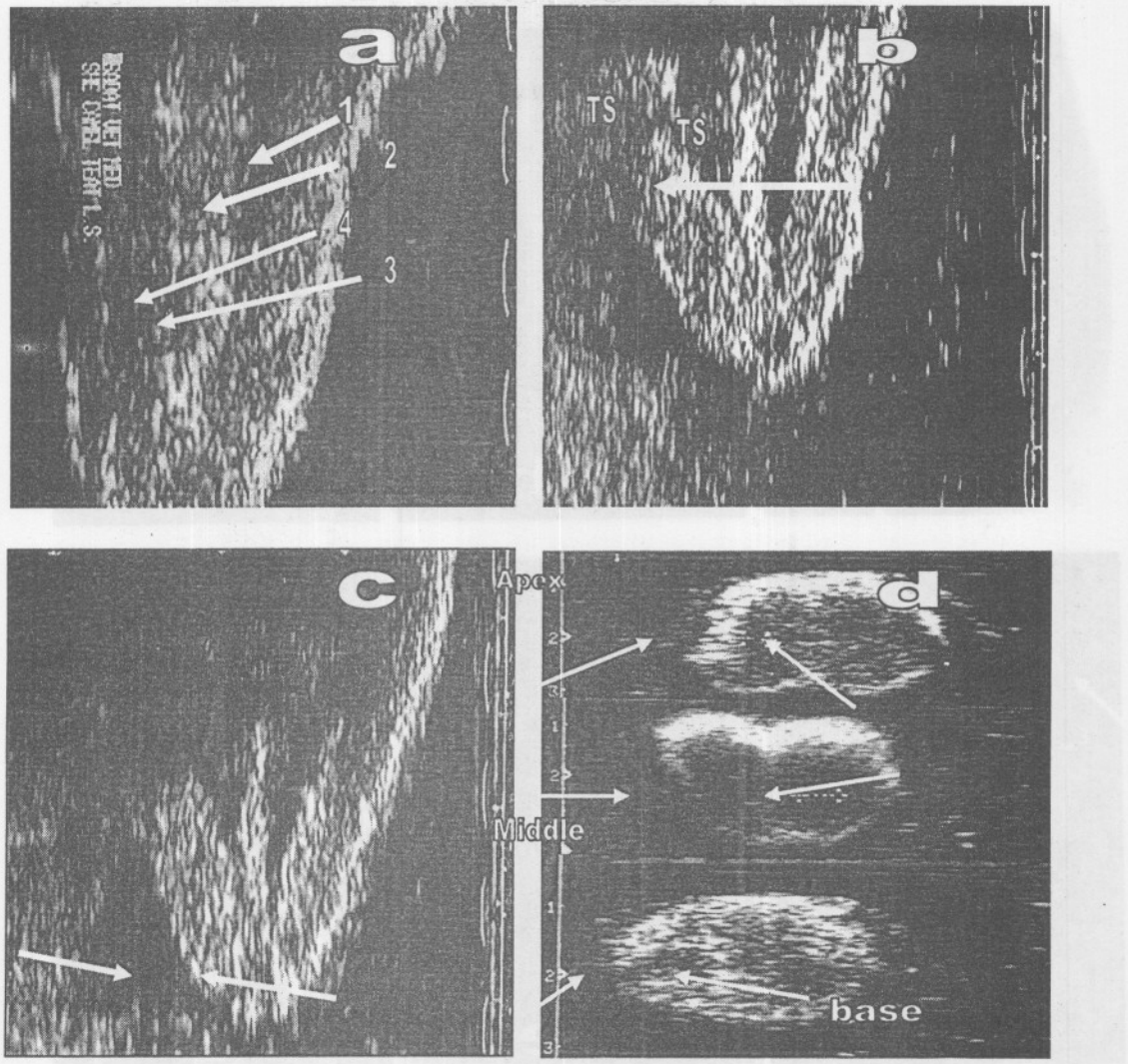

Fig. 3- (a & b & c) Sagittal ultrasound images of the normal teat dipped in a rubber glove filled with water. (a) The anatomic features are indicated by numbers and arrows: 1, skin-water interface (thick hyperechoic); 2, muscular and connective tissue layer (thick intermediate echoic); 3, vascular layer (thin anechoic); 4, mucosa (thin hyperehoic). (b) Two anechoic teat cisterns (TS) separated with hyperechoic connective tissue band (arrow). (c) Two streak canals demonstrated as two thin parallel hyperechoic lines (arrows). (d) Cross sections of the teat; the two anechoic teat cisterns are wide at the middle and tapered at both ends.

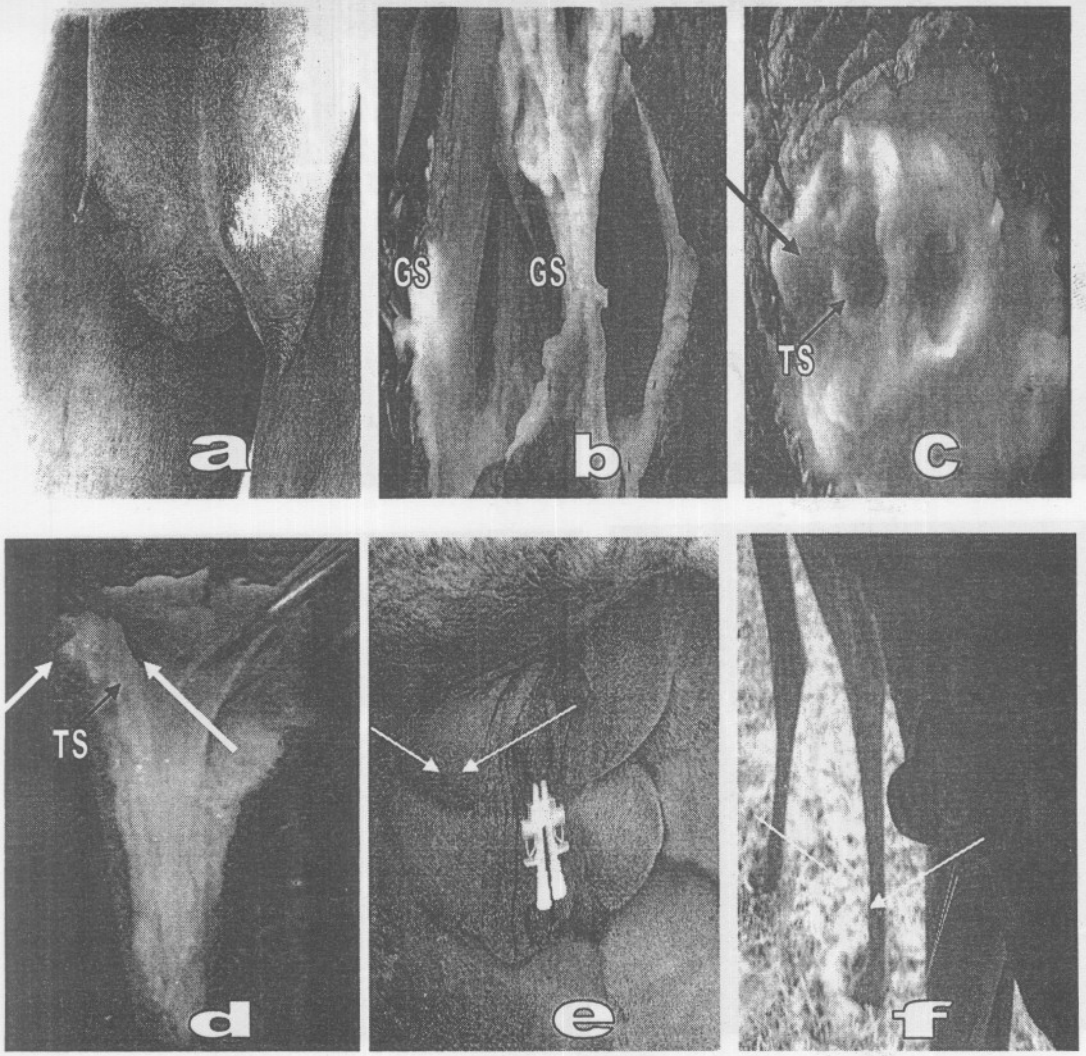

Fig. 4- Clinical and gross anatomical photographs for the mammary gland of one-humped she-camels. (a) Lactating mammary gland showing that the right half is separated than the left one and the fore teats are apart from each other and shorter than the hind ones. (b) Cross section of the right fore quarter showing two separate gland cisterns (GS). (c) Cross section near the base of the teat showing two teat cisterns (TS) separated with connective tissue septum (long arrow). (d) longitudinal section of the left hind teat showing the opening of communication (arrows) between the gland cistern and the teat cistern (TS). (e) Non- lactating mammary gland showing canulation of the two external opening of the right hind teat (arrows). Milking of the left fore teat showing two streams of milk omitted from two separate teat orifices (arrows).

At the base of each quarter two distinct gland cisterns were seen shared, a common hyperechoic wall while the cistern cavity appeared anechoic(fig 2 a&b). Sagittal images of gland cisterns revealed that each one leads to a patent anechoic teat cistern cavity with a hyperechoic mucosal wall (fig2 c&d).

Imaging of 56 teats of the examined 14 she-camels teats showed that each teat possessed hypoechogenic layer region represents the vessels, and an inner, hyperechoic layer represents the mucosa (fig 3 a). In sagittal and cross images each anechoic teat cistern ended with a separate streak canal, which appeared as two thin hyperechogenic lines separated by an intermediate echogenic connective tissue area (fig 3 b & c). In cross images positions the teat cistern width was wider at the middle than the base and apex (fig 3 d). In non-lactating animals, the teats were canulated using 23-gauge canula for confirmation of the number of streak canals and their potency (fig 4 e).

two-teat cisterns. The four-echogenic layers of the teat wall were clearly visible in 48 teats.

The very hyperechoic (white) outer region was the skin-air interface. The thickest, middle layer is intermediate in echogenicity and represents the muscular and connective tissue layers. A thin,

The results of the sonogram were confirmed through dissection of three mammary glands samples freshly obtained from the slaughterhouse. The mammary gland of the she-camel was formed from four quarters each one has its own teat (fig 4 a). Each quarter has two gland cisterns, which serve as a collecting duct for the respective gland within the duct (fig 4 b). Each gland cistern was continued distally to a separate teat cistern (fig 4 c& d). At the most distal aspect of the teat cistern is the streak canal, which communicates with the outside of the teat (fig 4 e & f).

DISCUSSION

The physiology and diseases of the udder are important factors for reproduction and production of Camelidae. Camel milk has been a source of nutrients for millions of people in Africa, Middle-eastern and Asian countries. Udder diseases not only affect the health and growth of newborns but may have alsoa public health hazards for populations consuming camel milk (Knoess, et al. 1986; Raymond, 1994). Although the above-mentioned facts,

above-mentioned facts, ultrasonographic studies of the mammary gland in one-humped she-camels are not studied up till now.

The normal she-camel glandular tissue ultrasonic image in the present study was uniformly echoic with the exception of the deep vascular layer deep to the mucosa. This echogenic pattern was attributed to the even distribution of connective tissue with a higher echoic density and gland parenchyma with less echoic density (Cartee, et al. 1986; Folck and Winter, 2006).

We found that each quarter possessed two-gland cisterns that depicted as an anechoic antrum. Saleh, et al. (1971); Smuts and Bezuidenhout, (1987); Flower, (1998) also observed the same number of gland cistern within each quarter. Folck and Winter, (2006) in cattle explained that the anechoic antrums may not always be determined correctly. They can correspond either to blood vessels or to lactiferous ducts.

At both cross and sagittal sonographs the entries of the large lactiferous ducts into the gland cistern were clearly visible in lactating she-camels than the non-lactating one. A similar finding was also observed by Cartee, et al. (1986); Ahmed, (2001) they noticed that echogenicity of lactiferous gland is dependent upon it is filling level. Moreover, Tibary and Anouassi, (2000) found that confirmation of the camel udder can change according to breed, age and stage of lactation.

The four-echogenic layers of the teat wall that mentioned by Trostle and O'Brien, (1998) in bovines were clearly identified in almost all examined she-camels teats. We also noticed that the width of the teat cistern in cross-ultrasonic images became wider at the middle than that at the apex and base. This result came along with the spindle-shaped teat cisterns observed by Saleh, et al. (1971).

In both sagittal and cross ultrasound images of all examined teats, the number of teat cisterns within each teat was only two. Each cistern appeared as anechoic antrum and separated from the other one with a hyperechoic connective tissue band. Each teat cistern was found communicated with the outside with a separate hyperehoic streak canal. The same result was obtained by Smuts and Bezuidenjout, (1987); Fowler, (1998) in South American camelidae. On the other hand, it contradicts with the postmortem radiographic study of Saleh, et al. (1971) in the one-humped camels. They mentioned that each teat

small pouch at the apex of the teat. Our results were confirmed by both gross anatomic and clinical examinations through

milking of the udder of lactating she-camels and canulation of non- lactating ones. Consequently, one-humped she-camels are not different than other camelidae species possessing only two teat cisterns each one open to outside through a separate streak canal.

The streak canal was not observed in five non-lactating she-camels while it appeared as a thin, hyperechoic, line in the rest of examined animals. Franz, et al. (2001) attributed the difficulty of observing the streak canal in sheep to the limited optical resolution of the scanner especially in small sized teats. The linear hyperechogenic appearance of the streak canal was attributed by Trostle and O'Brien, (1998); in cattle and Franz, et al.
(2003) in sheep to the opposition of the two opposing mucosal layers.

In conclusion, this article reviews the principles of ultrasonographic examination of the mammary gland in one-humped camels and its practices for visualization of glandular parenchyma as well as the collecting network. Moreover, the results of our clinical, ultrasonographic and gross anatomical examinations revealed that the glandular parenchymas as well as the collecting network of the mammary gland in one-humped camels are not differing than those in other Camelidae species. Consequently, ultrasonic imaging provides accurate details of the mammary gland in one-humped she-camels that will be helpful for further studies dealing with diagnosis of different mammary gland diseased conditions.

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"الصور بالموجات الفوق صوتية للضرع السليم عياديا في الإبل وحيدة السنام "

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تم تسجيل صور الموجات الفوق صوتية لضروع 14 ناقة وحيدة السنام (سليمة عياديا) وذلك باستخدام مجس طولي قوة 5- 7.5 ميجاهرتز. وقد تم تأكيد تلك النتائج بتشريح 3 عينات لضروع إناث ذبحت حديثا من المسلخ. وقد أستخلص البحث النتائج الآتية:

- يتميز النسيج اللبني الغددي لضروع النوق الغير حلابة بأن لة صدي صوتي عالي (hyperechoic) عنة في النوق الحلابة.
- يوجد بالجزء السفلي لكل ربع من الضرع حوضين منخفضي الصدى الصوتي(gland cisterns) ومشتركين في جدار واحد مرتفع الصدى الصوتي(hyperechoic).
- يتميز جدار الحلمة بوجود 4 طبقات مختلفة الصدى الصوتي(echogenic) . وقد لوحظ أن كل حلمة تحتوي علي حوضين(teat cisterns) منخفضي الصدى الصوتي(hypoechoic) يفصل بينهما نسيج ضام مرتفع الصدى الصوتي(hyperechoic). وان كل حوض من هذه الأحواض له قناة خطية خاصة (streak canal) تصله إلي خارج الضرع وتظهر كخط مرتفع الصدى الصوتي(hyperechoic).

وقد استخلصت الدراسة إن التصوير بالموجات الفوق صوتية من الممكن استخدامه بسهولة لفحص الضرع في النوق سواء كان الوضع واقفا أو راقدا. كما تحتوي الحلمات فقط علي حوضين (teat cisterns) لكل منهما قناة مستقلة (streak canal) لخروج الحليب إلي خارج الضرع. ولذلك يمكن استخدام الموجات الفوق صوتية لفحص ضروع النوق للمساعدة في تشخيص مختلف اعتلالات الضرع في النوق وحيدة السنام.