GROSS AND MICROSCOPIC ANATOMY OF MAMMARY GLAND OF DROMEDARIES UNDER DIFFERENT PHYSIOLOGICAL CONDITIONS

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ABSTRACT

Samples of 24 mammary glands from healthy one-humped camel (*Camelus dromedarius*) cows were investigated under different physiological conditions for their gross and light microscopic anatomy. Different groups included equal number of immature heifers, mature heifers, lactating and non-lactating animals. Tissues fixed in 10% NBF were processed as per routine and stained with hematoxylin and eosin (H&E) and Massons trichome. Morphometry was done with the help of stage and ocular micrometer. Gross studies revealed that the camel's udder consists of four quarters. The udder and teat showed light brown to solid black tinge in colour. The tips of teats sloped to a point both in immature and mature animals, however, the conformation of teats turned rounded at the tips in lactating camels. Each teat possessed two teat canals. The dimensions of teat and streak canal varied markedly among four different groups. Number of Furestenberg's rosettes ranged from 11.6 to13.6. Microscopic studies revealed that streak canal was lined by stratified squamous keratinized epithelium that was partially extremely thin in some parts. Cutaneous layer of teat was devoid of hair follicles except at the base of teat. Follicles were associated with sebaceous glands. Sweat glands were less coiled and showed a wide acinous element forming the part of excretory duct. Glomus organs occurred in the stratum profundum of the corium as well as in the subcutis of the skin of mammary gland. They also revealed great variation in structure and size. Epithelial lining of the alveoli varied from flattened to columnar according to physiological state. Number and size of alveoli per lobule decreased and the parenchyma was replaced by loose connective tissue during non-lactating phase. These results suggested that age and lactation considerably influenced gross and microscopic anatomy of mammary gland in camels.

Key Words: Camel cows, mammary glands, anatomy, histology, lactation, age.

INTRODUCTION

In arid zones and drylands, camel has been named as the goal animal in 21st century (EL-Naggar, 1998). Yagil (1990) said that with the help of modern science, poor farmers can raise camels for milk and can replace true cows, which in spite of their adaptability to the areas seem to have low potential for milk production compared to the dromedaries.

Udder and teat morphology has been associated with incidence of mastitis (Seykora and McDaniel, 1985). Recently, Mansfield and Tinsan (1996) have described that twin duct anatomy of teat plays major role in the protection against mastitis. It is, therefore, assumed that a complete anatomical picture of the mammary gland of dromedaries may be helpful to understand the mechanism of mastitis resistance in this unique specie.

The present study was conducted to investigate gross and microscopic anatomy of mammary gland of dromedaries comprising immature heifers, mature heifers, lactating and non-lactating camel cows. This information may be of help in understanding the diseases implicating mammary gland and predicting the prognosis in camel.

MATERIALS AND METHODS

Mammary gland specimens of 24 healthy one-humped camel (*Camelus dromedarius*) cows were collected from Lahore and Faisalabad Municipal abattoirs. The four groups consisted in equal numbers of immature heifers (below 3 years), mature (above 3 years), lactating and non-lactating camel cows. The age was estimated by dentition after the system evolved by Rabigliati (1924). Exterior anatomy of mammary gland was studied before slaughter. Tissue specimens for histology were collected immediately following slaughter. Specimens were preserved in 10% neutral buffered formalin and processed for light microscopy following Bancfort and Stevens (1990). Paraffin sections (4-5 μm) were stained with hematoxylin and eosin (H&E), and Massons trichome stains. All morphometeric studies were carried out with the help of ocular and stage micrometer. Size was measured by cross diameter (maximum diameter) and lateral extension (minimum diameter) following Ludewig (1998). All measurements were made in triplicate.

Means and standard deviations of all morphometeric parameters were calculated. Data was analyzed to investigate the possible effects of different physiological states under study by using analysis of variance technique. Duncan's multiple range test was applied for multiple mean comparison, where necessary. All computations were performed using SAS 6.12 computer software package.

RESULT AND DISCUSSION

The morphometrical results are presented in Table-1. Plates 1-6 show prominent histological features of different parts of the mammary gland of camel.

Gross studies on the mammary gland of female camel revealed that the udder of camel cow had four quarters with its own teat. The colour of mammary gland showed brown to black tinge. The mammary gland was cone-shaped in both immature and mature animals, however, the conformation of teats changed markedly with change in physiological state. In lactating females, the teat turned noticeably round at the tip. These findings were generally in agreement with Saleh *et al.* (1971) and Schwartz and Dioli (1992).

The morphometerical data revealed that teat length at maturity increased twice the size of immature heifer (7.95 + 0.01 cm vs 3.23 + 0.26 cm). The mean value of teat length of mature heifers in the present study was found similar to buffalo (7-8 cm) and cow (7.5-10cm) as reported by Sisson and Grossman (1985). Teat length increased ($P<0.05$) in lactating compared with non-lactating camels, which might be attributed to the functional activity. Like findings of Saleh *et al.* (1971), there was no considerable variation in teat length between right and left, and hind and rear teats.

The length of streak canal was double in mature than immature heifers (4.56 vs. 2.56 mm). This increase in length of streak canal in mature animals was due to development with progressing age. The length of streak canal was also greater ($P<0.05$) in lactating compared with non-lactating camel cows, which suggests effect of lactation on length of streak canal. The length of streak canal was lesser than in buffaloes (Uppal *et al.*, 1995) and in cows (Nickerson, 1994). These differences might be due to specie variations.

The circumference at apex and mid points of teat decreased significantly ($P<0.05$) in non-lactating compared with lactating camels. However, the difference was statistically non-significant at base of teat. This suggests tissue reconstitution under hormonal or other biochemical processes during involution period with probable loss of parenchyma. According to Banks (1993), the actively lactating glands have much parenchyma and little connective tissue. A constant and gradual increase was observed in circumference and diameter from apex to base of teat in all physiological conditions under study. These findings were in concordance with the findings of Saleh *et al.* (1971).

There were two streak canals namely, A and B (Plate 1) and epithelium of both showed higher ($P<0.05$) thickness in lactating camel compared with other groups under study. The luminal width of streak canal was higher ($P<0.05$) in mature than immature animals. Moreover, luminal width of steak canal was higher ($P<0.05$) in lactating camel compared to their non-lactating counterparts. These variations might be attributed to the developmental and physiological changes occurring in wake of maturity and lactation.

Microscopic studies revealed that streak canal was lined by stratified squamous keratinized epithelium that was partially extremely thin in some parts. Cutaneous layer of teat was devoid of hair follicles except at the base of teat. Follicles were associated with sebaceous glands (Plate 2). Sweat glands present were less coiled and showed a wide acinous element forming the part of excretory duct (Plate 3). In immature camels, the length and width of lactiferous duct were 25.6 and 2.66 μm, respectively. These values were much lower than other three groups of this study.

Furestenberg's rosettes are the vertical ridges in the mucosa of the streak canal (Plate 4). The number of Furestenberg's rosette ranged from 11.6 to13.6 in the present study, which were almost similar as reported in buffalo by Nickerson (1994), where they ranged from 10 -14 in buffaloes.

Glomus organs (Hoyer-Grosser's organs) were seen in the stratum profundum of the corium as well as the subcutis (Plate 5). Occasionally, they were also present in the deeper layer of the dermis. In histomorphometerical studies, many variations were recorded both in structure and size of the glomus organs. According to Weather *et. al* (1987), glomus organs develop in all body regions that confront with coldness, which might be the reason in these animals since the udder is a free hanging organ. Ludewig (1998) opined that glomus organs are important structures for controlling distribution of blood. Until now, the presence of glomus organs in the skin of camels was unreported. These results are, however, in agreement with the findings in other species, i.e., mare (Ludewig, 1998) and human beings (Kristic, 1994).

Epithelial lining of the alveoli varied from flattened to columnar according to physiological state. The alveolar epithelial cell attained their maximum height during lactational phase (Plate 6). The epithelial cells were columnar, ovoid and piriform in shape. The secretary ducts were lined by cuboidal epithelium. Number and size of alveoli per lobule were decreased similarly the parenchyma reduced and replaced by loose connective tissue during non-lactating phase.

Plate 1: Double streak canals in lactating dromedarian teat (thick layer of connective tissue separating two streak canals is prominent) 1: lumen of streak canal-A, 2: lumen of streak canal-B, 3: streak canal epithelium (stratified squamous keratinised epithelium), (H&E, x 100).

Plate 2: Haired skin at the base of dromedarian teat. Thin stratified squamous epithelium with partially keratinized. Hair follicles associated with sebaceous gland (dense irregular tissue). 1: Epidermis (stratified squamous keratinized epithelium), 2: Hair follicle, 3: medulla (Internal root sheath), 4: cortex. (external root sheath), 5: hair bulb, 6: sebaceous gland (H&E, x 400).

Plate 3: Group of apocrine sweat glands in the dermis of teat skin (1). Also, arrector pili muscles can be seen (2). (H&E, x 400).

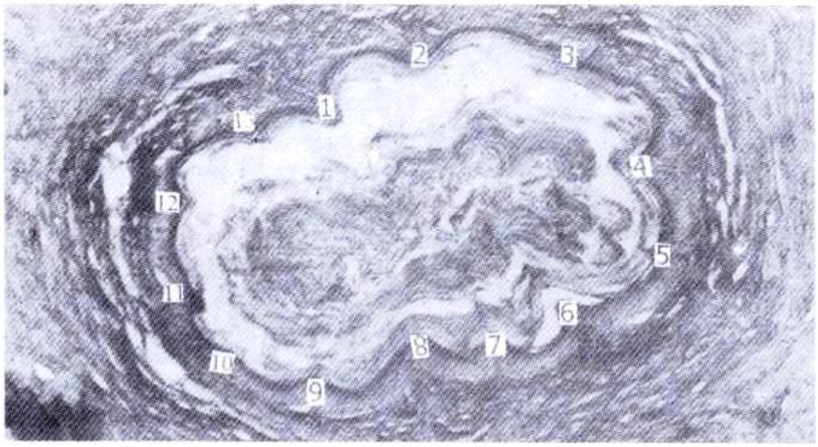

Plate 4: Furestenberg's rosettes (vertical ridges in the mucosa of the streak canal). Numerical figures indicate each rosette.

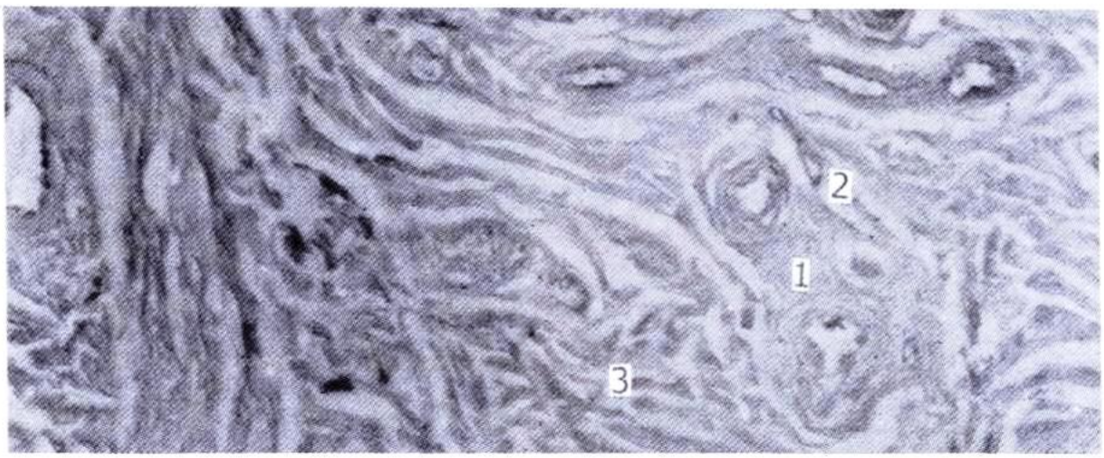

Plate 5: Glomus organs (Arterio-venous channels) in the cutis of skin of dromedarian mammary gland. 1: glomus organs, 2: capsule, 3: connective tissue (H&E, x 400).

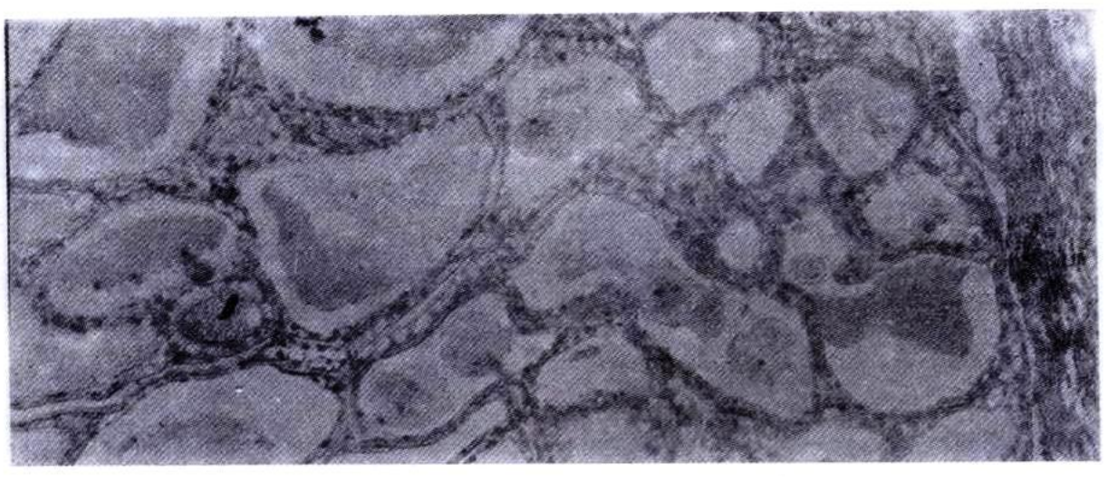

Plate 6: Mammary gland of lactating dromedaries. The parenchyma is predominant. Columnar, ovoid and piriform cells line the alveoli. The secretary ducts are lined by cuboidal epithelium.(Masson trichrome stain, x 400)

Table 1: Morphometeric observations on the mammary gland of one-humped camel (*Camelus dromedarius*) under different physiological conditions.

Parameters			Immature heifer (< 3 yrs.) n=6	Mature heifer (3-5 yrs.) n=6	Lactating n=6	Non-Lactating n=6
Length of teat (cm)			3.23d	7.95c	11.08a	8.83b
Length of streak canal (mm)			2.56b	4.56a	4.70a	4.58a
Diameter of streak canal (mm)			1.60c	2.61a	2.73a	2.00b
Apex of teat (cm)	Circumference		2.45d	6.00b	6.48a	3.40c
	Diameter		0.77b	1.90b	2.05a	1.09c
Mid of teat (cm)	Circumference		3.31d	7.06b	7.91a	6.08c
	Diameter		1.05d	2.24b	2.51a	1.93c
Base of teat (cm)	Circumference		7.96c	8.96a	9.10a	8.78b
	Diameter		2.53c	2.85a	2.89a	2.79b
Thickness of teat epithel (µm)			7.08b	8.66a	6.38c	8.60a
Thickness of streak canal epithelium (µm)		A	10.83b	13.33a	13.66a	10.83b
		B	9.83b	12.00a	12.33a	10.33b
Streak Canal Luminal width (µm)		A	45.16c	88.00b	99.00a	78.83b
		B	35.50b	72.67a	67.33a	53.33a
Streak Canal Luminal length (µm)		A	144.50a	113.67b	163.33a	150.00a
		B	152.00a	106.17c	147.50a	128.33c
Lactiferous duct (µm)		Length	25.6a	32.50a	38.8a	27.5a
		Width	2.66b	3.16a	3.83a	3.83a
No. of Frustenburg's rosette		A	12.3a	13.6a	11.6a	13.00a
		B	12.5a	12.6a	11.5 a	12.6a

Means with different letters in the same row are different (P<0.05). Capital A and B indicate two structures

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