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 trichrome. 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 to 13.6. 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 Rabiglioni (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 Bancroft and Stevens (1990). Paraffin sections (4-5 μm) were stained with hematoxylin and eosin (H&E), and Massons trichrome stains. All morphometric 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 morphometric 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 morphometrical 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
(7.5–10 cm) 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 species 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 Panks
(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 streak 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 lacticiferous 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 to 13.6 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
histomorphometrical 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
secretory 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 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 pinform cells line the alveoli. The secretory ducts are lined by cuboidal epithelium (Masson trichrome stain, x 400)
Table 1: Morphometric observations on the mammary gland of one-humped camel (Camelus dromedarius) under different physiological conditions.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Immature heifer (n=6)</th>
<th>Mature heifer (3-5 yrs.) (n=6)</th>
<th>Lactating (n=6)</th>
<th>Non-Lactating (n=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of teat (cm)</td>
<td>3.23d</td>
<td>7.95c</td>
<td>11.08a</td>
<td>8.83b</td>
</tr>
<tr>
<td>Length of streak canal (mm)</td>
<td>2.56b</td>
<td>4.56a</td>
<td>4.70a</td>
<td>4.58a</td>
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<td>Diameter of streak canal (mm)</td>
<td>1.60c</td>
<td>2.61a</td>
<td>2.73a</td>
<td>2.00b</td>
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<tr>
<td>Apex of teat (cm)</td>
<td>2.45d</td>
<td>6.00b</td>
<td>6.48a</td>
<td>3.40c</td>
</tr>
<tr>
<td>Mid of teat (cm)</td>
<td>3.31d</td>
<td>7.06b</td>
<td>7.91a</td>
<td>6.08c</td>
</tr>
<tr>
<td>Base of teat (cm)</td>
<td>2.55c</td>
<td>2.85a</td>
<td>2.85a</td>
<td>2.76b</td>
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<tr>
<td>Thickness of teat epithelium (µm)</td>
<td>7.08b</td>
<td>8.66a</td>
<td>6.38c</td>
<td>6.60a</td>
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<tr>
<td>Thickness of streak canal A</td>
<td>10.63b</td>
<td>13.33a</td>
<td>13.66a</td>
<td>10.63b</td>
</tr>
<tr>
<td>epithelium (µm) B</td>
<td>9.83b</td>
<td>12.00a</td>
<td>12.33a</td>
<td>10.33b</td>
</tr>
<tr>
<td>Streak Canal Luminal width (µm)</td>
<td>45.16c</td>
<td>88.00b</td>
<td>90.00a</td>
<td>78.83b</td>
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<tr>
<td>Streak Canal Luminal length (µm)</td>
<td>144.50a</td>
<td>113.67b</td>
<td>163.33a</td>
<td>150.00a</td>
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<td>Lactiferous duct (µm)</td>
<td>25.5a</td>
<td>32.50a</td>
<td>38.8a</td>
<td>27.5a</td>
</tr>
<tr>
<td>No. of Frustenberg's rosette</td>
<td>12.3a</td>
<td>13.5a</td>
<td>11.5a</td>
<td>13.00a</td>
</tr>
<tr>
<td></td>
<td>12.5a</td>
<td>12.5a</td>
<td>11.5a</td>
<td>12.5a</td>
</tr>
</tbody>
</table>

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

REFERENCES


El-Naggar, M. A. 1998. The camel is the goal animal in arid zones and dry lands for the coming 21st Century. Production under arid conditions (Camel Production and Future Perspectives). 2-3 May, Al-Ain, UAE.


Yagil, R. 1990. Camel’s milk one hump or two? The Economist, October 20.