

# MORPHOMETRIC ANALYSIS OF HEART, KIDNEYS AND ADRENAL GLANDS IN DROMEDARY CAMEL CALVES

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## ABSTRACT

Morphometric evaluation of the heart, kidneys and adrenal glands is critical in the determination of etiology and pathogenesis of different diseases especially related to cardiovascular system in domestic animals as well as in human beings. In this study the heart, kidneys and the adrenal glands of 26 dromedary camels, aged between 30 to 36 months were studied gross anatomically. All organs were weighed with the help of an electrical weighing balance whereas length, width and circumference were measured with measuring tape. Thickness of wall of the heart was measured using Vernier caliper. Shape of the heart was cone like; the coronary and longitudinal grooves were filled with white fat. Means $\pm$ SEM of the gross anatomical parameters estimated were: heart weight:  $1136.53 \pm 53.1$  g; heart length from base to apex:  $19.54 \pm 0.44$  cm; heart width:  $14.59 \pm 0.28$  cm; coronary heart circumference:  $36.33 \pm 0.57$  cm; thickness of right atrial wall:  $0.52 \pm 0.04$  cm; thickness of left atrial wall:  $0.51 \pm 0.03$  cm; thickness of the right ventricular wall:  $0.83 \pm 0.05$  cm; thickness of the left ventricular wall:  $1.95 \pm 0.08$  cm. Parameters related to kidneys gave following values: weight of left kidney:  $683.5 \pm 36$  g; renal length:  $15.04 \pm 0.33$  cm; renal width:  $10.75 \pm 0.24$  cm; renal circumference (around the poles of kidney):  $25.41 \pm 0.48$  cm; diameter of cortex:  $1.26 \pm 0.05$  cm; diameter of medulla:  $4.12 \pm 0.11$  cm; weight of right kidney:  $725.61 \pm 40$  g; renal length:  $15.54 \pm 0.35$  cm; renal width:  $10.98 \pm 0.27$  cm; renal circumference of left kidney:  $25.93 \pm 0.52$  cm; thickness of cortex:  $1.35 \pm 0.04$  cm; thickness of medulla:  $4.43 \pm 0.1$  cm; averages  $\pm$ SEM recorded with regard to adrenal glands were: weight of left adrenal gland:  $16.58 \pm 0.8$  g; length:  $5.15 \pm 0.22$  cm; width:  $3.33 \pm 0.13$  cm. Weight of right adrenal gland:  $18.97 \pm 0.8$  g; length:  $5.81 \pm 0.19$  cm and width of right adrenal gland was found to be  $3.84 \pm 0.11$  cm. Considering these values, dromedary camel, appears to have better developed these organs than other ruminant species to cope up the stresses of the harsh climate.

**Key words:** Adrenal glands, camel calves, heart, kidneys, morphometry

Among the domestic animals, camel has a unique and peculiar physiology which enables this dubious animal to survive in its tiring environment (Majeed *et al*, 1980). The better knowledge of morphological norms and the causes of their variations are essential not only for a better understanding of physiology but also for a correct diagnosis and prognosis of disease (Sarwar *et al*, 1991).

The heart, kidneys and adrenal glands are interconnected through renin-angiotensin-aldosterone mechanism and play an important role in the blood pressure regulation (Saavedra and Trimmermans, 1994; Robertson, 1994). The kidneys play an important role in maintaining the normal blood pressure through regulation of water excretion. A change within a species is only possible by variation in filtering surface of renal corpuscle. At the same time, landmark clinical studies have demonstrated that inhibition of these

systems significantly reduces morbidity and mortality from a wide spectrum of cardiovascular diseases including myocardial infarction, heart failure and diabetes. Width of *zona glomerulosa* of adrenals and the cell nucleus size of the endocrine cells are also very much important in this regard.

The close structure-function relationship prompted us to go for the biometry of organs directly involved in heart related problems namely heart, kidneys and adrenal glands.

## Materials and Methods

A total of 26 clinically healthy one-humped camel calves (*Camelus dromedarius*), aged between 30-36 months, were used in this study. The samples of the heart with pericardium, the left and right kidneys and the left and right adrenal glands along with fat tissue were collected from each animal immediately after slaughter at the abattoir in winter.

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Following collection, gross anatomical parameters including shape, weight, dimensions (length, width, circumference) of heart, kidneys and adrenal glands; thickness of wall of the heart at different locations (right and left atria and ventricles), renal cortex and renal medulla were measured. All organs were weighed with the help of an electrical weighing balance whereas length, width and circumference were measured with measuring tape. Thickness of atrial walls of the heart were measured from auricular walls and those of ventricles were measured midway between atrioventricular orifice and apex of heart, using Vernier Caliper.

Descriptive statistics was calculated for each parameter investigated with the help of computer software Microsoft Excel. The means of parameters of kidney and adrenal glands of right and left sides were compared with t-test. Statistical analysis was performed by using the statistical computer software Minitab (Mtb13).

## Results and Discussion

### Heart

The camel's heart was found strongly conical and pointed in shape with a rich deposition of fat, especially around the coronary groove. The colour of heart was reddish brown as can be visualised in Fig 1. These findings were in line with those described by Schwartz and Dioli (1992) and Wilson (1984).

Mean value of heart weight of 26 camel calves was recorded as  $1.14 \pm 0.053$  Kg with a range of 0.96-1.72 Kg. No literature was available to compare these values in camels of same age group. However, these values were considerably lower than in the mature ones (1.5-2 Kg) as described by Schwartz and Dioli (1992). Lower heart weight is apparently due to lower body weight and size in the young animals as compared to the mature ones. Panhwar *et al* (2004) has reported heart weight of young male and female buffalo calves (1-2 years) as 550 and 540 g, respectively. Values reported by Panhwar *et al* (2004) are lower from those in the young camels, due to younger age group.

The means ( $\pm$ SEM) and ranges of all parameters related to heart of young dromedary camel calves, aged between 30-36 months are given in Table 1. No literature was available to compare the parameters related to heart of camels of this age group. However, Panhwar *et al* (2004) studied length and circumference of heart in young male buffalo-calves (1-2 years) and reported relatively lower means of 13.9 and 27.6 cm, respectively. Ellenberger and Baum (1974) studied circumference of heart in the adult cattle and

reported a slightly higher range of 37-51.8 cm than that recorded in the present study. Left ventricular wall was significantly ( $P<0.05$ ) thicker than the right one, as in case of other animals (Getty *et al*, 1975). This difference can be clearly be visualised in Fig 1, 2 and 3.

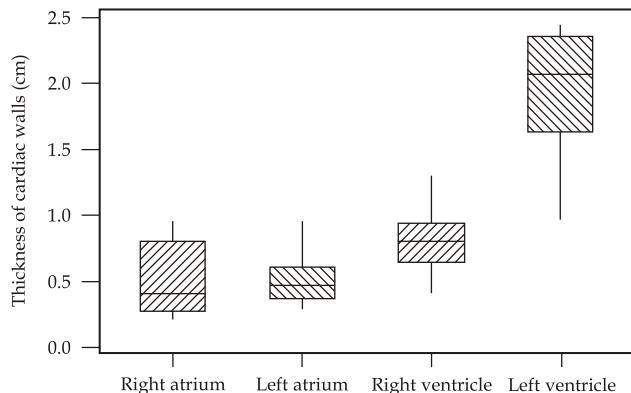


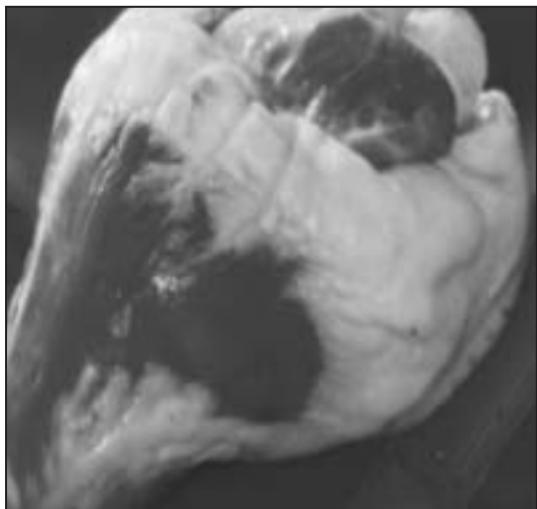
Fig 1. Comparison of thickness of the atrial and ventricular wall of right and left side.

### Kidneys

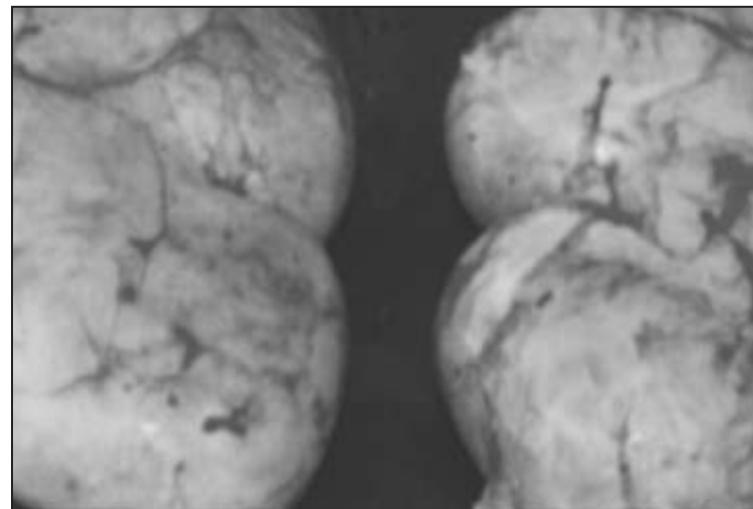
Overall profile of both the left and right kidneys of camel calves under study was bean-shaped. Main mass of kidney was reddish brown in colour with thick white capsule as depicted in Fig 2 and 4. These findings were in line with those of Zguigal and Ouhsine (2004) and Schwartz and Dioli (1992). Kidneys of camel were non-lobulated and contained a renal pelvis, contrary to those of cattle and buffaloes as reported by Getty *et al* (1975) and Hussain *et al* (2005). This shape is similar to kidneys of goat, sheep and horses.

The average absolute weights of left and right kidneys were  $683.5 \pm 36$  and  $725.61 \pm 40$  g, respectively. The ranges for left and right kidneys were 413-1075 and 483 -1230 g, respectively. The mean weights of right and left kidneys were comparable to those reported by Zguigal, and Ouhsine (2004) in their non-descript camels. Schwartz and Dioli (1992) reported heavier kidneys weighing about 1 Kg in adult camels. Heavier kidneys in mature animals and lighter ones in the young animals can be attributed to age. May (1970) has reported almost same values in adult cattle (0.7 and 0.65 Kg) and horses (0.7 and 0.68 Kg). Hussain *et al* (2005), however, reported a relatively large mean weight of kidneys ( $937 \pm 41.55$  g) in buffaloes aged up to 42 months. This literature suggests that kidneys of camel gain weight with age, however, these are of similar weight as in adult cattle and horses.

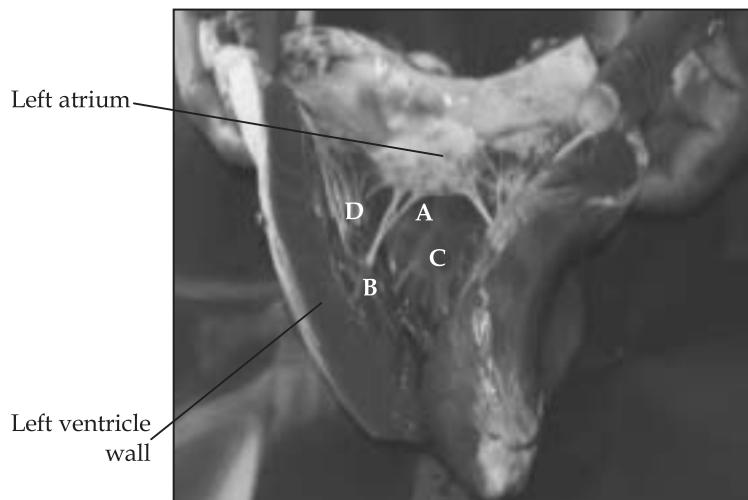
Comparison of mean values of various dimensions (length, width and circumference) of



**Fig 1.** Morphology of camel's heart: reddish brown colour, pointed apex and deposition of large quantity of fat may be noted.

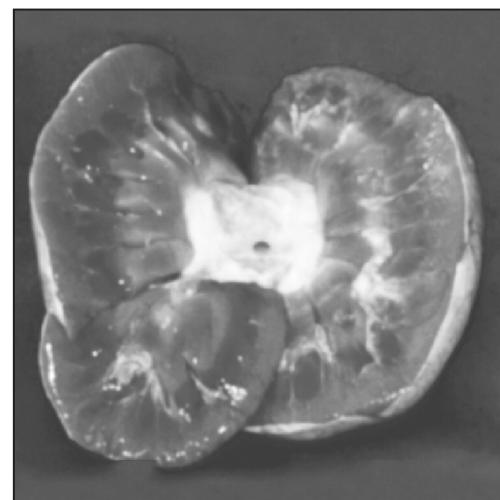


**Fig 4.** External conformation of right and left kidneys: Bean shaped profile may be appreciated.



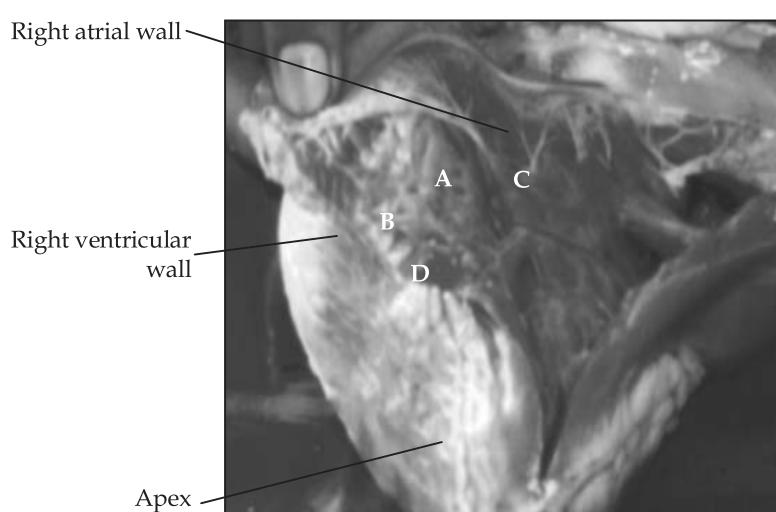
**Fig 2.** Incised left aspect of heart showing exclusive thickness of ventricular wall and internal conformation

A: Bicuspid valve      B: Papillary muscle  
C: Trabeculae cornea      D: Chordae tendinae



**Fig 5.** Sagittal section of a kidney showing 1:4 ratio of cortex: medulla, which is distinctive feature of camel's kidneys.

A: Renal Cortex      B: Renal Medulla  
C: Renal Pelvis      D: Renal Capsule



**Fig 3.** Incised right half of heart showing thin ventricular wall.

A: Tricuspid valve  
B: Trabeculae cornea  
C: Chordae tendinae  
D: Papillary muscle

**Table 1.** Mean  $\pm$  SEM and ranges of different gross anatomical parameters of heart in the camel calves

| Parameter                                | Mean $\pm$ SEM     | Range         | Significance        |
|--|--------------------|---------------|---------------------|
| Weight (g)                               | 1136.53 $\pm$ 53.1 | 961-1720      |                     |
| Length (base to apex) (cm)               | 19.54 $\pm$ 0.44   | 16 - 23.75    |                     |
| Width (base) (cm)                        | 14.60 $\pm$ 0.28   | 12.25 -17.5   |                     |
| Circumference (coronary groove) (cm)     | 36.34 $\pm$ 0.57   | 31.25 - 42.25 |                     |
| Thickness of right atrial wall (cm)      | 0.597 $\pm$ 0.04   | 0.21 - 0.96   | 0.098 <sup>NS</sup> |
| Thickness of left atrial wall (cm)       | 0.508 $\pm$ 0.03   | 0.29 - 0.95   |                     |
| Thickness of right ventricular wall (cm) | 0.82 $\pm$ 0.047   | 0.41-1.66     | 0.00*               |
| Thickness of left ventricular wall (cm)  | 1.96 $\pm$ 0.082   | 0.97-2.45     |                     |

NS = Non significant; \* = Significant at 5 per cent level

**Table 2.** Mean  $\pm$  SEM values of length, width and circumference of right and left kidneys (g) with ranges in the camel calves.

| Parameters                | Sides | Mean $\pm$ SEM   | Range      | Significance        |
|---------------------------|-------|------------------|------------|---------------------|
| Length (cm)               | Left  | 15.05 $\pm$ 0.33 | 12.5-17.75 | 0.309 <sup>NS</sup> |
|                           | Right | 15.54 $\pm$ 0.35 | 12.9-19    |                     |
| Width (cm)                | Left  | 10.75 $\pm$ 0.24 | 8.75-13    | 0.523 <sup>NS</sup> |
|                           | Right | 10.99 $\pm$ 0.27 | 8.87-14    |                     |
| Circumference (cm)        | Left  | 25.41 $\pm$ 0.48 | 20-30      | 0.47 <sup>NS</sup>  |
|                           | Right | 25.93 $\pm$ 0.52 | 20.5-34.5  |                     |
| Thickness of cortex (cm)  | Left  | 1.26 $\pm$ 0.05  | 1-3        | 0.180 <sup>ns</sup> |
|                           | Right | 1.35 $\pm$ 0.04  | 1-2.5      |                     |
| Thickness of medulla (cm) | Left  | 4.19 $\pm$ 0.1   | 3.25-5     | 0.129 <sup>ns</sup> |
|                           | Right | 4.43 $\pm$ 0.1   | 3.25-5.25  |                     |

NS= Non-Significant

**Table 3.** Means  $\pm$  SEM of weight and dimensions (length and width) of adrenal glands of camel calves

| Parameters  | Side  | Mean $\pm$ SEM  | Range     | Significance      |
|-------------|-------|-----------------|-----------|-------------------|
| Weight (g)  | Left  | 15.23 $\pm$ 1.2 | 4-27      | 0.1 <sup>ns</sup> |
|             | Right | 19.7 $\pm$ 1.7  | 8-32      |                   |
| Length (cm) | Left  | 5.15 $\pm$ 0.22 | 3-8       | 0.026*            |
|             | Right | 5.8 $\pm$ 0.19  | 3.75-7.5  |                   |
| Width (cm)  | Left  | 3.3 $\pm$ 0.13  | 1.75-4.75 | 0.004*            |
|             | Right | 3.84 $\pm$ 0.11 | 2.5-5     |                   |

NS = Non Significant; \* =  $P < 0.05$ 

left and right kidneys are depicted in table 2. These mean length, width and circumferences of left and right kidneys in camel calves recorded were relatively lower than that reported by Zguigal and Ouhsine (2004) and Schwartz and Dioli (1992) in adult camels. These low values might be attributed to young age of animals under study.

Mean thickness of renal cortex and medulla, in the left and right kidneys of camel calves were in accordance with those reported by Abdalla and Abdalla (1979) who reported a ratio of 1:4 between cortex and medulla. Present study indicated a similar

ratio. In contrast, Schwartz and Dioli (1992) reported a ratio of 1:1. Higher ratio of 1:4 between cortex and medulla is responsible for the production of alkaline urine in the camel, suitable for their living conditions. This fact is supported by Sarmad and Anas (2006) that renal glomeruli are smaller in diameter in camels as compared to other ruminants.

Heavier kidneys along with exclusively large renal medulla (cortex: medulla = 1:4) might play an essential role in the conservation of body water and electrolytes for the maintenance of homeostasis in dehydrating conditions.

#### Adrenal glands

Average weights, lengths and widths of left and right adrenal glands of camel calves studied are mentioned in table 3. Statistical analysis revealed that right adrenal gland was significantly ( $P < 0.05$ ) longer and wider as compared to the left ones. No literature was available about the adrenal glands of same age group in camels. However, these means generally fall on the lower bound of ranges given by Schwartz and Dioli (1992) and Al Baghdadi *et al* (1969), who have reported these values for adult camels.

## Conclusion

Considering these values dromedary camels probably, has better developed these three organs than other ruminant species to cope up the stresses of the harsh climate.

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