

## AGE RELATED CHANGES IN THE MORPHOMETRIC PARAMETERS OF THE HEART, KIDNEYS AND ADRENAL GLANDS OF NILI-RAVI BUFFALO (*BUBALUS BUBALIS*)

R. HUSSAIN, A. S. QURESHI, R. U. SHAHID AND S. U. RAHMAN<sup>1</sup>

Department of Veterinary Anatomy, <sup>1</sup>Department of Veterinary Microbiology,  
University of Agriculture, Faisalabad, Pakistan

### ABSTRACT

This study was carried out to improve the basic information on the morphology and histology of the organs directly involved in the blood pressure maintenance of an individual. A total of 40 clinically healthy Nili-Ravi buffaloes (*Bubalus bubalis*) were divided into two age groups of 20 animals each viz., young (12-48 months of age) and adult (49-96 months) of either sex. The results revealed that the absolute weights of heart, kidneys and adrenal glands, mean values of width and circumference of heart, thickness of wall of right and left atria and ventricles, mean values of length of right and left kidneys, width, circumference, and length of the adrenal glands were significantly ( $P < 0.05$ ) higher in adult buffaloes than young ones. The average relative weights of heart, kidneys and adrenal glands were significantly ( $P < 0.01$ ) higher in young buffaloes as compared to the adult ones. The relationship of the width of right adrenal glands between young and adult buffaloes was non-significant. It is concluded that the absolute weight, width, circumference and length of heart, kidneys and the adrenal glands increase, while relative weights of these organs decrease with advancing age.

**Key words:** Anatomy, heart, kidneys, adrenal glands, buffalo, age.

### INTRODUCTION

Nili-Ravi buffalo (*Bubalus bubalis*) is ranked as the best dairy breed of the world. Pakistan is the world's largest buffalo meat producer, followed by India, China, Thailand and Vietnam. There are about 25.5 million head of buffaloes in Pakistan (Anonymous, 2004). In view of the important role of buffalo in the rural economy of Pakistan, this specie is known as the "Black Gold" of the country.

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). Renin is produced by the juxtaglomerular cells of kidneys, its secretion is increased by stimuli that decrease extra-cellular fluid (ECF) volume and blood pressure or increase sympathetic output (William, 1995). Renin converts angiotensinogen (present in blood stream) into angiotensin-I, the latter is converted into angiotensin-II by the action of angiotensin converting enzyme (ACE). Angiotensin-II produces arteriolar constriction and a rise in systolic and diastolic blood pressure. Angiotensin-II also acts directly on the adrenal cortex to increase the secretion of aldosterone (life saving) and has direct effect on the blood pressure of individual (Guyton and Hall, 1996).

Extensive research work has been carried out to improve the basic information on the morphology and histology of the bovine heart, kidneys and adrenal glands during past few decades (Nagra *et al.*, 1989; Görlach, 1992; Mischke, 1997; Morovvati and Alboghobesh, 2002).

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 diseases (Sarwar *et al.*, 1991). The present work was carried out to study the morphometry of major organs involved in cardiovascular problems and blood pressure regulation through renin-angiotensin-aldosterone system i.e. heart, kidneys and adrenal glands in young and adult Nili-Ravi buffaloes (*Bubalus bubalis*) of either sex.

### MATERIALS AND METHODS

Forty clinically healthy Nili-Ravi buffaloes (*Bubalus bubalis*) of either sex were divided into two age groups with equal numbers viz., young (12-48 months) and adult (49-96 months). The samples of the heart, the left and right kidneys and the left and right adrenal glands along with fat tissue were collected from each animal immediately after slaughter from the local abattoir. The body weight of the animals was estimated by the following formulae, as described by Khan *et al.* (2004):

For young (up to 48 months):

$$Y = -1697.226 + (16.761) X_1 + (23.947) X_2 + (0.514) X_3$$

For adult (49-96 months):

$$Y = -1604.790 + (1.268) X_1 + (30.902) X_2 + (3.960) X_3$$

Where Y= Live weight in pounds,  $X_1$ = Height in inches,  $X_2$ = Girth in inches,  $X_3$ = Length in inches

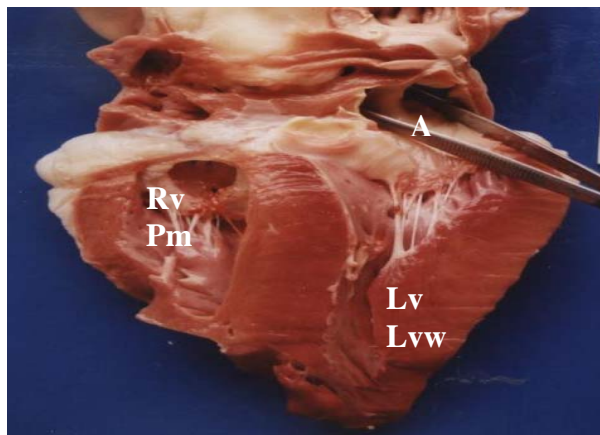
Following collection, parameters including absolute weight, relative weight, length, width, circumference, thickness of wall of right and left atria

and ventricles of heart were recorded. The absolute and relative weights of kidneys, length, width, and circumference of the left and right kidneys and the left and right adrenal glands were also recorded. The samples were weighed with the help of electrical weighing balance. The Vernier's Calipers was used for the measurement of thickness of the right and left atrial and ventricular walls of heart. The means, standard error of mean (SEM) and ranges for each parameter were computed using Microsoft Excel software. Group means of young and adult animals were compared by Student's t-test. All computations were done with the statistical software MSTAT.

## RESULTS AND DISCUSSION

### Heart

The heart of the buffalo was conical in shape and had pointed ventricular part, having thick left ventricular wall (Plate 1). The mean values of absolute heart weight, length, width and circumference were significantly ( $P < 0.05$ ) higher in adult animals than young ones (Table 1). Similarly, the mean values of thickness of wall of right atrium of adult buffaloes were significantly ( $P < 0.05$ ) higher than young ones. The walls of left and right ventricles were thicker ( $P < 0.01$ ) in adults than their counterparts. These findings are in general conformation with Panhwar *et al.* (2004), who reported a significant increase in the size of heart with progressive age in buffaloes. Many workers have studied these parameters in cattle and reported a rise in heart weight with advancing age (Mischke, 1997).



**Plate 1:** Section of heart of adult buffalo (49 months) showing the conformation. Conical and pointed ventricular part and thick left ventricular wall are visible. A=Aorta, Rv=Right ventricle, Ct=Chordea tendinae, Pm= Papillary muscle, Lv= Left ventricle, Lvw= Left ventricular wall

### Kidneys

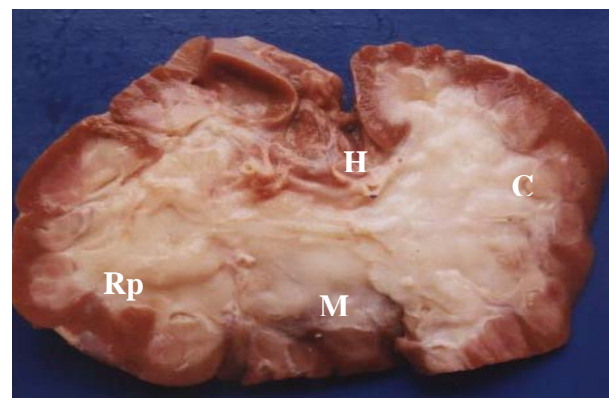
In buffaloes, renal pelvis was absent, renal papillae projected into calyx minor and renal columns were very

**Table 1:** Mean values ( $\pm$  SEM) of anatomical parameters of heart in young (12-48 months) and adult (49-96 months) buffaloes

Parameters	Young	Adult
Absolute heart weight (g)	1606 $\pm$ 53.86	2561 $\pm$ 71.57**
Relative heart weight (%)	0.43 $\pm$ 0.004	0.42 $\pm$ 0.04*
Length (cm)	17.57 $\pm$ 0.52	24.34 $\pm$ 0.54**
Width (cm)	15.18 $\pm$ 0.41	19.85 $\pm$ 0.34**
Circumference (cm)	30.87 $\pm$ 0.92	39.10 $\pm$ 0.79**
Thickness of wall of right atrium (cm)	1.33 $\pm$ 0.05	1.65 $\pm$ 0.03**
Thickness of wall of left atrium (cm)	1.74 $\pm$ 0.04	1.86 $\pm$ 0.04*
Thickness of wall of right ventricle (cm)	1.49 $\pm$ 0.03	2.76 $\pm$ 0.12**
Thickness of wall of left ventricle (cm)	1.9 $\pm$ 0.03	3.17 $\pm$ 0.14**

\* = Significant at  $P < 0.05$ ; \*\* = Significant at  $P < 0.01$

prominent (Plate 2). The macroscopic studies revealed that the average absolute weight of both the kidneys in adult buffaloes was significantly ( $P < 0.05$ ) higher as compared to their young counterparts. The mean values of length of right and left kidney are significantly ( $P < 0.01$ ) higher in adult buffaloes than young ones. Same was true for the width of right and left kidneys. Similarly, the mean values of circumference of right and left kidneys were significantly ( $P < 0.01$ ) higher in adult than young ones (Table 2). No literature was available to compare these results in buffaloes. These results were however, in agreement with Mischke (1997), who reported a similar trend in cattle.



**Plate 2:** Section of left kidney of a young buffalo (36 months of age) showing its internal structure. Pelvis is absent, renal papillae project into calyx minor, renal columns are very prominent. H= Hilus, Rp= Renal papilla, M= Medulla, C= Cortex

**Table 2: Mean values ( $\pm$  SEM) of anatomical parameters of kidneys in young (12-48 months) and adult (49-96 months) buffaloes**

Parameters	Young	Adult
Absolute weight of both kidneys (g)	937.0 $\pm$ 41.55	1285 $\pm$ 22.55**
Relative weight of both kidneys (%)	0.25 $\pm$ 0.003	0.21 $\pm$ 0.004**
Length of right kidney (cm)	18.61 $\pm$ 0.32	19.56 $\pm$ 0.32**
Length of left kidney (cm)	18.59 $\pm$ 0.45	21.96 $\pm$ 24.05*
Width of right kidney (cm)	12.22 $\pm$ 0.14	13.46 $\pm$ 0.26*
Width of left kidney (cm)	12.45 $\pm$ 0.21	13.58 $\pm$ 0.25**
Circumference of right kidney (cm)	23.76 $\pm$ 0.310	26.73 $\pm$ 0.54**
Circumference of left kidney (cm)	24.46 $\pm$ 0.40	26.60 $\pm$ 0.41**

\* = Significant at  $P < 0.05$ ; \*\* = Significant at  $P < 0.01$

#### Adrenal gland

In the buffalo, the left adrenal gland was flattened, V-shaped, while right adrenal gland was C-shaped, having convex lateral surface (Plate 3). The average absolute weight of both adrenal glands was significantly ( $P < 0.01$ ) higher in adults as compared to young animals. The mean values of length of adrenal glands were significantly ( $P < 0.01$ ) higher in adult than young ones. However, the difference between the width of right adrenal gland of young and adult buffaloes was non-significant. The mean values of circumference in right adrenal gland were significantly ( $P < 0.01$ ) higher in adult than young ones (Table 3). These values are in line with Morovvati and Alboghobesh (2002), who reported same trend with the advancing age in buffaloes. Mischke (1997) reported same tendency in cattle.



**Plate 3: Dorsal views of right and left adrenal glands of an adult buffalo (49 months of age). La= Left adrenal gland (flattened, V-shaped), Ra= Right adrenal gland (C-Shaped, convex lateral surface).**

**Table 3: Mean values ( $\pm$  SEM) of anatomical parameters of adrenal glands in young (12-48 months) and adult (49-96 months) buffaloes**

Parameters	Young	Adult
Absolute weight of both adrenal glands (g)	23.70 $\pm$ 1.12	33.85 $\pm$ 1.17**
Relative weight of both adrenal glands (%)	0.06 $\pm$ 0.001	0.05 $\pm$ 0.001**
Length of right adrenal gland (cm)	5.03 $\pm$ 0.05	6.69 $\pm$ 0.09**
Length of left adrenal (cm)	5.17 $\pm$ 0.08	6.85 $\pm$ 0.100**
Width of right adrenal gland (cm)	3.84 $\pm$ 0.06	4.13 $\pm$ 0.015 <sup>NS</sup>
Width of left adrenal gland (cm)	2.85 $\pm$ 0.05	4.82 $\pm$ 0.22**
Circumference of right adrenal gland (cm)	7.40 $\pm$ 0.19	8.17 $\pm$ 0.34**
Circumference of left adrenal gland (cm)	5.75 $\pm$ 0.35	9.30 $\pm$ 0.47**

\* = Significant at  $P < 0.05$ ; \*\* = Significant at  $P < 0.01$ ; NS = Non-significant

On the basis of present comparative investigations it is concluded, that absolute weights, width, circumference and length of heart, kidneys and the adrenal glands increase, while relative weights of these organs decrease with advancing age.

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