PHYSIOLOGICAL ANATOMY OF THE HEART AND LUNG IN BUFFALO (*BUBALUS BUBALIS*) AND HOLSTEIN STEERS

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Introduction

It is commonly known that the heart rate and the respiration rate in the buffalo are lower than those in the cattle (Kuzuno and Terada, 1940). Furthermore, the oxygen consumption per unit volume of the inhaled air is higher in buffalo than in cattle (Chikamune et al., 1986). Since the metabolic rates per body weight are similar between the two species, it is likely that buffalo have either a more efficient oxygen transporting mechanism or a higher cardiac output than cattle. Although a number of researchers have demonstrated various aspects of the physiological responses in buffalo, information on the physiological anatomy of heart and lung is scarce. The aim of the present study, therefore, is to obtain basic information on the physiological anatomy of the buffalo heart and lung in comparison with the cattle.

Materials and Methods

Twenty-one lung-heart complexes from buffalo steers were collected at a slaughter house in Bangkok, Thailand. The same number of the lung-heart complexes from Holstein steers were obtained in Ibaraki, Japan. The body weight of the buffaloes was calculated from the carcass weight, assuming that the carcass weights were 50% of the body weight. The live body weight in the Holsteins was measured prior to slaughtering. The lung weight (LW), the heart weight (HW), the artery diameters, the cardiac circumference (CC), and the cardiac length (CL; the distance between the base of pulmonary artery and the *apex cordis*) were measured (figure 1).

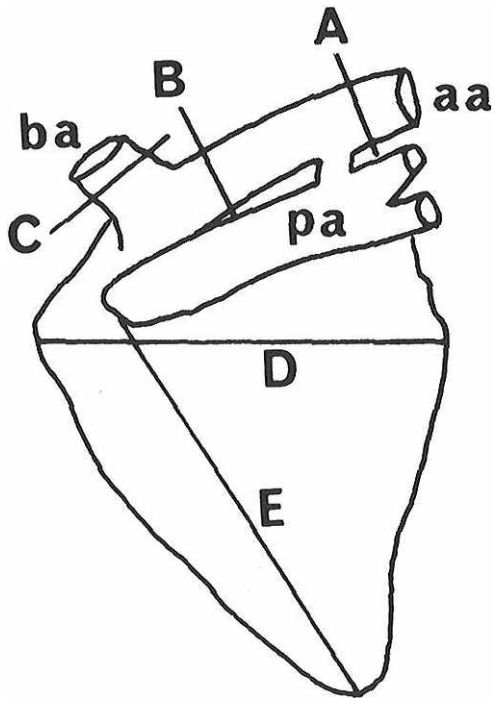

Figure 1. Schematic diagram of the heart showing the sites of measurement. External and internal diameters of the arteries were measured at site A, B, and C, A; Arch of Aorta adjacent to Ligamentum arteriosum, B; Arch of Aorta adjacent to Brachiocephalic trunk. C; Brachiocephalic trunk. Cardiac circumference and length were measured at site D and site E, respectively. aa; arch of aorta, pa; pulmonary art. ba; brachiocephalic trunk.

Results

The results are shown in table 1. The mean heart weight and the mean lung weight were 2.1 ± 0.26 kg and 3.0 ± 0.46 kg or 0.54 ± 0.06% and 0.76 ± 0.11% of the body weight in the buffaloes, respectively. Similarly, the mean heart weight and

TABLE 1. HEART WEIGHT, LUNG WEIGHT, DIAMETER OF THE ARTERIES, CARDIAC CIRCUMFERENCE, AND CARDIAC LENGTH IN BUFFALO AND HOLSTEIN STEERS (n=21)

	Buffalo	Holstein
BW	389 ± 48	713 ± 25
HW	2.1 ± 0.26	3.0 ± 0.26
LW	3.0 ± 0.46	3.4 ± 0.20
CC	46.1 ± 2.83	51.7 ± 2.63
CL	21.3 ± 1.42	24.1 ± 1.55
EDA at A	36.8 ± 3.30	38.7 ± 3.11
IDA at A	23.1 ± 3.44	26.0 ± 2.02
EDA at B	32.0 ± 2.56	37.1 ± 2.21
IDA at B	21.2 ± 2.86	27.0 ± 2.09
EDA at C	24.0 ± 2.79	28.9 ± 2.48
IDA at C	14.3 ± 2.67	19.3 ± 2.33

Abbreviations: BW; body weight (kg), HW; heart weight (kg), LW; lung weight (kg), CC; cardiac circumference (cm), CL; cardiac length (cm), EDS; external diameter of the artery (mm), IDA; internal diameter of the artery (mm), see figure 1. for A, B, and C.

the mean lung weight in the Holsteins were 3.0 ± 0.26 kg and 3.4 ± 0.20 kg or 0.42 ± 0.04% and 0.47 ± 0.03% of the body weight in the Holsteins, respectively. The ratio between the external and internal diameter of the arteries (EDA/IDA ratio) at site A, B, and C (figure 1) was 1.61 ± 0.17, 1.53 ± 0.21 and 1.71 ± 0.25 in the buffaloes and 1.49 ± 0.17, 1.38 ± 0.10 and 1.51 ± 0.15 in the Holsteins, respectively. The cardiac circumference and the cardiac length were 46.1 ± 2.83 cm and 21.3 ± 1.42 cm in the buffaloes and 51.7 ± 2.63 cm and 24.1 ± 1.55 cm in the Holsteins, respectively. The ratio between the two (CC/CL ratio) in the buffaloes and the Holsteins was 0.463 ± 0.003 and 0.467 ± 0.035, respectively.

Discussion

It was found in the present study that the heart weight in the buffaoles was 0.54% of the body weight. This result agreed with Camoens (1976) who reported that the heart weight in the Malaysian buffaloes was on average 0.56% of the body weight.

In the present study, the heart weight relative to the body weight in the buffaloes was significantly heavier than that of the Holsteins ($P < 0.05$). On the other hand, it has been reported that they both have a similar metabolic rate per body weight (Chikamune et al., 1986). Furthermore, buffaloes display a lower heart rate than Holsteins (Chikamune, 1987). From these observations, it was suggested that the stroke volume of heart in relation to the body size could be larger in buffalo than that of the cattle.

The ratio between the cardiac circumference and the cardiac length (CC/CL) was almost identical in the buffaloes and the Holsteins ($P > 0.05$). This result indicates that the heart of the two species is similar in shape.

It was found, in the present study, that the lung was 0.76% of the body weight although Camoens (1976) reported that the lung weight in the buffalo was 1.2% of the body weight. Since it was shown in the Holsteins that the lung was 0.47% of the body weight, there appears to be an interspecific differences in the percentage lung weight between the buffaloes and the Holsteins. Assuming that the capillary size and its distribution in the lung are similar in the buffalo and the cattle, the buffalo would have a higher proportion of blood in the lung than the cattle. If this assumption holds, the relationship between the relative lung size and the physiological parameters i.e. heart rate or respiration rate, should be studied.

The EDA/IDA ratio was highest at site C and lowest at site B among the three aortic sites studied. The aortic blood pressure *in vivo* is presumbly higher at site B than at site A due to the closer location to the left ventricle. However, in the present, study, both EDA/IDA ratio and aortic diameter in the buffaloes were higher at site A than site B. Further research on the relationship between aortic blood pressure and the EDA/IDA ratio should be conducted.

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(Key Words: Buffalo, Heart, Lung)

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