

Comparative Morphological Studies of Adrenal glands in Large white Yorkshire Pigs reared at Low and High altitudes in Kerala

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ABSTRACT

The present study was conducted to record the topographical and morphologic features of the adrenal glands in 24 ten-month-old Large White Yorkshire pigs of either sex reared at low-altitude and high-altitude regions of Kerala. Adrenal glands were positioned either cranio-medially or entirely medially to the kidneys. The left adrenal was elliptical, whereas the right was elongated. The average weight and length of adrenals did not reveal any significant difference between the male animals reared at low and high altitudes and between the females reared at low and high altitudes. However, within the same altitude, the female groups had heavier right and left adrenal glands than the corresponding male groups.

Key words: Adrenal glands, Altitude, Morphology, Pig

Pigs are an important part of the Indian livestock sector and have emerged as one of India's fastest-growing divisions of the agricultural sector. Pigs are generally raised by economically weaker sections of society, which provide them with better nutritional support and an important source of livelihood (Sulabh *et al.*, 2017). Pigs are sensitive to high ambient temperatures. The adrenal gland plays a vital role in an animal's adaptation to the environment and production (Sharma *et al.*, 2020). Literature recorded the variation in the adrenal gland function in response to stress in animals (Aggarwal *et al.*, 2005; Sejian and Srivastava, 2010) and in high-altitude in human beings (von Wolff *et al.*, 2018). Reports are available on the gross morphology of adrenal glands in pigs (Singh, 2007; Kumar and Sharma, 2019; Panwar *et al.*, 2020). However, a comparative morphological data in animals reared at different altitudes are unavailable in pigs. Hence, the present study was undertaken.

MATERIALS AND METHODS

The samples for the study were collected from 24 ten-month-old Large White Yorkshire pigs from the slaughter houses located in the low-altitude (Meat plant, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala elevation 2.83 m) and high-altitude (Sulthan Bathery, Wayanad district, Kerala elevation 930 m) areas. Animals

were divided into four groups, *viz.*, low-altitude male group, low-altitude female group, high-altitude male group, and high-altitude female group; each group comprised six animals.

Prior to slaughter, the body weight of the animals were recorded. The topographic relationships of the adrenal glands, including their position and relationship with other viscera, were recorded during the evisceration process immediately after slaughter. Later, the adrenal glands were carefully separated and collected from each animal. Excess connective tissue was dissected, and gross morphological features were recorded after transferring the organs into a tray at 4 °C. The individual weight of the adrenal glands (g) was measured separately for the right and the left glands using a digital weighing balance. Each adrenal gland's length, width, and thickness parameters (cm) were recorded using a graduated scale and Vernier callipers. The average values of the right and left glands in every group were calculated. The data were analysed statistically using SPSS software (version 24.0). An Independent t-test was performed to determine the correlation between the morphometric parameters of adrenal with sex and altitude.

RESULTS AND DISCUSSION

The average body weight of the male animals in the low-altitude and high-altitude groups was 103.52 ± 0.87 kg and 92.18 ± 1.13 kg, respectively. The average body weight of female animals in the

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low-altitude and high-altitude groups was 101.23 ± 0.49 kg and 102.27 ± 1.63 kg, respectively.

The adrenal glands were observed either cranio-medial or entirely on the medial surface of the kidney, lateral to the aorta and caudal vena cava, and embedded entirely within the perirenal fat of kidney in male and female pigs (Fig. 1) as reported by Panwar *et al.* (2020) in Large White Yorkshire pigs, wherein the entire medial position of the adrenal was not reported. Both the left and right adrenal glands were smooth, dorsoventrally flattened, and reddish brown. The right adrenal was elongated, and the left was elliptical, indicating asymmetry between the right and left glands in pigs (Fig. 2). The glands presented macroscopically two distinct zones, an outer cortex, and an inner medulla. The colour and shape of the glands observed in the study were analogous to the reports of Kumar and Sharma (2019) in pigs. However, Singh (2007) reported a yellowish-brown colour, and Panwar *et al.* (2020) stated a brown colour for the pig adrenal glands. The shape of the gland observed differed from Singh (2007), who reported bean-shaped glands in pigs.

Comparative morphometric data of adrenal glands of male and female animals at low and high altitudes have been summarized in Tables 1, 2, 3, and

4. Among the four groups, the maximum average weight for the right and left adrenal glands was observed in the high-altitude female group. There was no statistically significant difference in the adrenal gland weight of the low-altitude males and females to the corresponding high-altitude groups. Within the low-altitude group, the average weight of the right and left adrenals was significantly higher in the female group as compared to the corresponding male groups ($p < 0.01$). Similarly, within the high-altitude group, the average weight of the right and left adrenal was significantly higher in the female group compared to the corresponding male groups ($p < 0.05$). The above recorded data suggest sexual dimorphism for the adrenal in pigs. Our data concurred with Kumar and Sharma (2019) in pigs, who stated that the left adrenal gland is heavier than the right adrenal gland in pigs. However, the data on the weight parameter disagreed with Panwar *et al.* (2020) in Large White Yorkshire pigs, who reported low weights compared to the present study. The body weight of the animals employed in the study might affected the difference in the adrenal gland weight parameters to the earlier reported works. Further, all those authors did not consider the sex of the animal. When the weight of

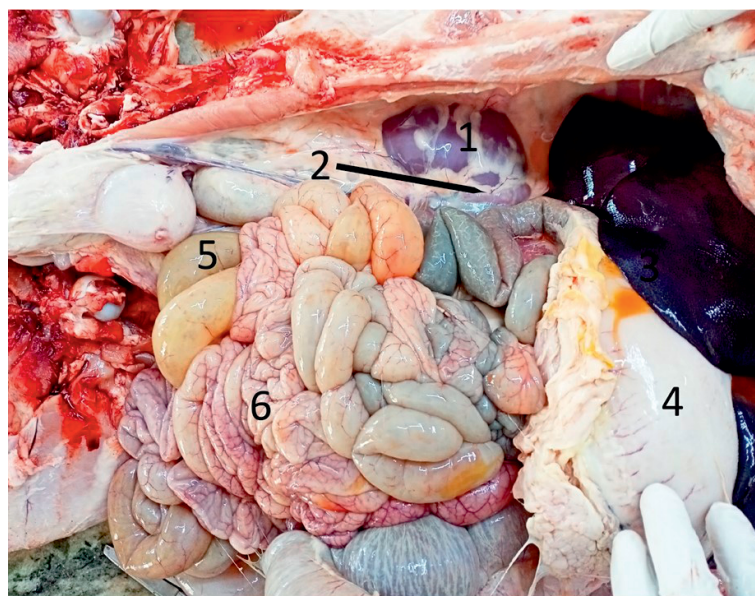


Fig. 1: *In situ* position of right adrenal 1-Right kidney, 2- Right adrenal, 3- Liver, 4- Stomach, 5- Large intestine, 6-Small intestine

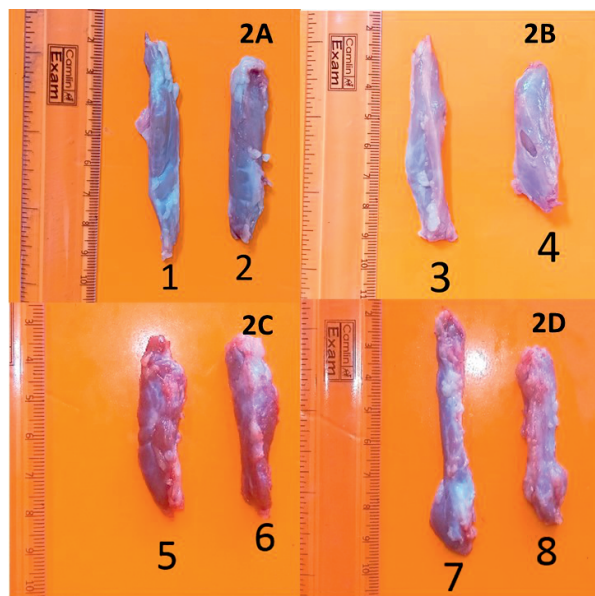


Fig. 2: Morphology of adrenal glands at low and high altitudes: Adrenal glands of male animals - at low-altitude (2A), - at high-altitude (2B); 1- Right adrenal (low altitude); 2- Left adrenal (low altitude); 3- Right adrenal (high altitude); 4- Left adrenal (high altitude); Adrenal glands of female animals - at low-altitude (2C), - at high-altitude (2D); 5- Right adrenal (low altitude); 6- Left adrenal (low altitude); 7- Right adrenal (high altitude); 8- Left adrenal (high altitude)

was analysed with the animal body weight, in the male animals, the total average weight of adrenal glands was 5.38 g and 5.34 g per 100 kg of the body weight in the low-altitude and high-altitude groups, respectively. The corresponding values in the female animals were 7.43 g and 9.77 g per 100 kg of body weight in the low-altitude and high-altitude groups, respectively. A measure of organ weight to the animal's body weight will be a better comparison parameter than simply the organ weight.

Table 1: Comparison of adrenal parameters of male animals between low-altitude and high-altitude (Mean $\pm$ SE)

Variables (cm) or (g)	Low altitude	High altitude
Weight (Right)	2.65 $\pm$ 0.15 ^a	2.29 $\pm$ 0.23 ^a
Weight (Left)	2.92 $\pm$ 0.22 ^a	2.63 $\pm$ 0.28 ^a
Length (Right)	5.34 $\pm$ 0.36 ^a	5.12 $\pm$ 0.26 ^a
Length (Left)	4.69 $\pm$ 0.19 ^a	4.88 $\pm$ 0.26 ^a
Width (Right)	1.26 $\pm$ 0.07 ^a	1.18 $\pm$ 0.09 ^a
Width (Left)	1.61 $\pm$ 0.1 ^a	1.16 $\pm$ 0.09 ^a
Thickness (Right)	0.97 $\pm$ 0.09 ^a	0.66 $\pm$ 0.09 ^a
Thickness (Left)	0.72 $\pm$ 0.05 ^a	0.5 $\pm$ 0.06 ^a

*Values with the same superscript in a row did not differ significantly, Values with different superscript in a row differ significantly at 0.05 level, *Significant at 0.01 level*

Table 2: Comparison of adrenal parameters of female animals between low-altitude and high-altitude (Mean $\pm$ SE)

Variables (cm) or (g)	Low altitude	High altitude
Weight (Right)	3.58 $\pm$ 0.21 ^a	4.5 $\pm$ 0.85 ^a
Weight (Left)	3.94 $\pm$ 0.22 ^a	5.48 $\pm$ 0.88 ^a
Length (Right)	6.56 $\pm$ 0.37 ^a	7.37 $\pm$ 0.38 ^a
Length (Left)	5.63 $\pm$ 0.29 ^a	6.20 $\pm$ 0.65 ^a
Width (Right)	1.27 $\pm$ 0.08 ^a	1.28 $\pm$ 0.03 ^a
Width (Left)	1.41 $\pm$ 0.1 ^a	1.36 $\pm$ 0.07 ^a
Thickness (Right)	0.99 $\pm$ 0.06 ^a	0.87 $\pm$ 0.15 ^a
Thickness (Left)	0.83 $\pm$ 0.07 ^a	0.72 $\pm$ 0.1 ^a

Values with the same superscript in a row did not differ significantly

Table 3: Comparison of adrenal parameters between male and female animals in low-altitude (Mean $\pm$ SE)

Variables (cm) or (g)	Male	Female
Weight (Right)	2.65 $\pm$ 0.15 ^a	3.58 $\pm$ 0.21 ^a
Weight (Left)	2.92 $\pm$ 0.22 ^a	3.94 $\pm$ 0.22 ^a
Length (Right)	5.34 $\pm$ 0.36 ^a	6.56 $\pm$ 0.37 ^a
Length (Left)	4.69 $\pm$ 0.19 ^a	5.63 $\pm$ 0.29 ^a
Width (Right)	1.26 $\pm$ 0.07 ^a	1.27 $\pm$ 0.08 ^a
Width (Left)	1.61 $\pm$ 0.1 ^a	1.41 $\pm$ 0.1 ^a
Thickness (Right)	0.97 $\pm$ 0.09 ^a	0.99 $\pm$ 0.06 ^a
Thickness (Left)	0.72 $\pm$ 0.05 ^a	0.83 $\pm$ 0.07 ^a

*Values with the same superscript in a row did not differ significantly, Values with different superscript in a row differ significantly at 0.05 level, *Significant at 0.01 level*

Table 4: Comparison of adrenal parameters between male and female animals in high-altitude (Mean $\pm$ SE)

Variables (cm) or (g)	Male	Female
Weight (Right)	2.29 $\pm$ 0.23 ^a	4.5 $\pm$ 0.85 ^a
Weight (Left)	2.63 $\pm$ 0.28 ^a	5.48 $\pm$ 0.88 ^a
Length (Right)	5.12 $\pm$ 0.26 ^a	7.37 $\pm$ 0.38 ^a
Length (Left)	4.88 $\pm$ 0.26 ^a	6.2 $\pm$ 0.65 ^a
Width (Right)	1.18 $\pm$ 0.09 ^a	1.28 $\pm$ 0.03 ^a
Width (Left)	1.16 $\pm$ 0.09 ^a	1.36 $\pm$ 0.07 ^a
Thickness (Right)	0.66 $\pm$ 0.09 ^a	0.87 $\pm$ 0.15 ^a
Thickness (Left)	0.5 $\pm$ 0.06 ^a	0.72 $\pm$ 0.1 ^a

*Values with the same superscript in a row did not differ significantly, Values with different superscript in a row differ significantly at 0.05 level, *Significant at 0.01 level*

The recorded morphometric data in pigs were similar to the reports of Singh (2007) and Kumar and Sharma (2019). However, the morphometric parameters of the adrenal gland partially disagreed with the records by Panwar *et al.* (2020) in Large White Yorkshire pigs, who reported larger values. The present study observed that the right adrenal was longer and thicker than the left adrenal in all the groups indicating asymmetry. The

data agreed with the reports of Kumar and Sharma (2019) in pigs and disagreed with the reports of Panwar *et al.* (2020) in Large White Yorkshire pigs. When the morphometric parameters of the adrenal gland were compared to altitude, no significant difference existed in the length of the right and left adrenal glands between the male animals of low-altitude to high-altitude groups and between the female animals of low-altitude to high-altitude groups. The width of the left adrenal and the thickness of both right and left adrenals revealed a significant difference ($p < 0.05$) between the male animals of the low-altitude group to the high-altitude group. However, a similar statistically significant difference was absent in the female animals of the low-altitude group to the high-altitude group.

When the animal groups were compared within the altitude concerning sex, the average length of both the right and left adrenal was significantly higher in the low-altitude female group than in the low-altitude male group ($p < 0.05$). But, in the high-altitude groups, a similar significant difference in length existed only for the right adrenal ($p < 0.001$). The recorded data on the weight and morphological parameters suggest the occurrence of sexual dimorphism of the adrenal in pigs.

Adrenal glands were smooth, reddish brown in colour, and placed either cranio-medial or entirely medial to the kidneys. The shape of the adrenal glands on the right and left sides differed. The right adrenal was longer and thicker than the left in all the groups. The average weight and length of the adrenals differed between male and female pigs. The morphometric parameters, like the adrenal's width and thickness revealed a statistically significant difference in the animals reared at the two altitudes only in males but not in females.

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