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## Gross anatomy and Biometry of Proventriculus and Gizzard of Pigeon (*Columba livia domestica*)

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### Abstract

This study was conducted on the proventriculus and gizzard of the six dead pigeons (*Columba livia domestica*) for gross anatomical and biometrical observations. Grossly, the proventriculus was short, thick-walled, spindle-shaped tubular organ, extending from the caudal end of the esophagus to the cranial end of the gizzard. At the caudal end, there was a constricted area called the isthmus in between the proventriculus and the gizzard. The gizzard is highly muscular organ, resembling a biconvex lens-shaped disc. The cranial end of gizzard made contact with the caudal end of the liver lobes and the caudal end of the gizzard was related to the duodenum and pancreas. Biometrically, the Mean  $\pm$  SE value of length of proventriculus and gizzard was  $2.52 \pm 0.04$  cm and  $2.48 \pm 0.03$  cm, respectively. The Mean  $\pm$  SE value of circumference of the proventriculus at the cranial, middle, and caudal parts was  $2.10 \pm 0.04$  cm,  $2.48 \pm 0.06$  cm, and  $2.71 \pm 0.12$  cm, respectively. The Mean  $\pm$  SE value of circumference and maximum thickness of wall of the gizzard was  $7.78 \pm 0.11$  cm, and  $1.48 \pm 0.06$  cm, respectively.

**Keywords:** Proventriculus, gizzard, pigeon, gross anatomy, biometry

### Introduction

The gross anatomy and biometry of the proventriculus and gizzard in pigeons have been subjects of interest for researchers studying avian anatomy. Pigeons are highly specialized birds with unique adaptations in their digestive system to efficiently process their grain-based diet. The proventriculus and gizzard play crucial roles in the digestive process, and understanding their anatomy and biometry provides valuable insights into the functional adaptations of these organs. The proventriculus, also known as the glandular stomach, is responsible for the initial chemical breakdown of food. It secretes gastric juices that contain enzymes, acids, and mucus, which help in the breakdown of proteins and other nutrients. The gross anatomy and biometry of the proventriculus in pigeons provide important information about its size, shape, and histological features, shedding light on its functional capabilities in the digestive process.

The gizzard, also called the muscular stomach, is a highly specialized organ involved in the mechanical breakdown of food. It possesses strong muscular walls and contains grit or small stones that aid in the grinding and crushing of food particles. The gross anatomy and biometry of the gizzard in pigeons provide insights into its size, muscular strength, and the presence of grinding materials, all of which contribute to its mechanical digestive function.

Studying the gross anatomy and biometry of the proventriculus and gizzard in pigeons helps in understanding the adaptations that enable these birds to efficiently process their diet. It provides information about the structural features and functional capacities of these organs, including their size, shape, muscular strength, and specialized components. Additionally, comparing the proventriculus and gizzard between different avian species can offer valuable comparative anatomy data, highlighting the evolutionary adaptations related to diet and feeding strategies.

In this study, we aim to explore the gross anatomy and biometry of the proventriculus and gizzard in pigeons, focusing on their size, shape, histological features, muscular strength, and the presence of grinding materials. By examining these aspects, we aim to gain a comprehensive understanding of the structural and functional characteristics of these digestive organs in pigeons.

Such knowledge contributes to our understanding of avian anatomy, physiology, and the adaptations necessary for efficient digestion in birds.

## Materials and Methods

In the present study conducted on the proventriculus of pigeons, a total of six pigeon carcasses were obtained from two sources: the kite festival organized by the Namo Namah Parivar Bird Camp -2020 in Ahmedabad and the Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, K. U., Anand. The research work took place in the Department of Veterinary Anatomy and Histology, College of Veterinary Science and Animal Husbandry, Anand, Gujarat.

**Sample collection:** Six pigeons were used for gross anatomical and biometrical studies.

**Processing, Dissection, and Preservation:** The collected pigeon carcasses were defeathered to facilitate clean dissection of the visceral organs. A sharp dissection scissor was used to make an incision along the posterior margin of the sternum, allowing careful reflection of the thoracic region. A mid-ventral incision on the neck was made to expose the cervical, thoracic, and abdominal visceral organs. Following dissection, the entire carcasses were fixed in a 10% formalin solution for 48 hours for gross anatomical and biometrical studies.

**Gross anatomical study:** The fixed proventriculus organs were examined in situ to determine their topographic positions. They were also studied ex-situ to evaluate their shape, size, and other gross morphological features such as the shape and size of mucosal folds.

**Biometrical Study:** Measurements of the proventriculus included length, width, circumference, and the number of mucosal folds. These measurements were taken using a magnifying lens, calibrated Vernier calipers, non-elastic thread, and a measuring tape.

**Statistical data analysis:** Statistical analysis was performed using IBM SPSS Statistics 20 (Trial Version). Biometrical and micrometrical data were presented as Mean  $\pm$  SE (Standard Error) values and coefficient of variation. An independent samples t-test was employed to determine significant differences between two groups, while One-Way Analysis of Variance (ANOVA) was used to determine significant differences among three groups.

**Photography:** Gross photographs of the proventriculus organs were captured using a Sony Cyber-Shot DSC-HX400 Prosumer Camera (20.4 MP). These methods allowed for the comprehensive examination and measurement of the proventriculus in pigeons, providing valuable data for the gross anatomical and biometrical characterization of this digestive organ.

## Results and Discussion

### Proventriculus

**Gross anatomy:** The proventriculus of the pigeon was observed to be a short, thick-walled, spindle-shaped tubular organ, extending from the caudal end of the esophagus to the cranial end of the gizzard (Figure 1). This observation is consistent with findings in chicken (McLelland, 1975) [6],

Elanus caeruleus (Hamdi *et al.*, 2013) [3], and laughing dove (Al-Kinany, 2019) [1]. Topographically, the proventriculus was located dorsal to the liver and between the two bronchi, and ventral to the lungs (Figure 2). There was no clear demarcation between the esophagus and proventriculus at the cranial end (Figure 3, 4), similar to the findings in chicken (McLelland, 1975) [6] and laughing dove (Al-Kinany, 2019) [1]. At the caudal end, there was a constricted area called the isthmus between the proventriculus and the gizzard (Figure 3, 4). The presence of the isthmus in pigeons is consistent with findings in *Gallus gallus* and *Gallus domesticus* (Turk, 1982) [8], captive bustard (Bailey *et al.*, 1997) [2], and laughing dove (Al-Kinany, 2019) [1], but differs from the absence of an isthmus in *Elanus caeruleus* (Hamdi *et al.*, 2013) [3]. The outer surface of the proventriculus appeared glistening and smooth (Figure 4), while the internal surface exhibited a whitish color and numerous rounded areas representing the luminal openings of the proventricular glands (Figure 4). These gross anatomical observations are consistent with previous studies conducted in chicken (McLelland, 1975) [6], laughing dove (Al-Kinany, 2019) [1], and guinea fowl (Saran *et al.*, 2019) [7].

**Biometry:** The mean length of the proventriculus in the pigeons studied in this research was found to be  $2.52 \pm 0.04$  cm. This measurement differs from the lengths reported in quail and pigeons, which were  $2.38 \pm 0.20$  cm and  $1.44 \pm 0.28$  cm, respectively (Hena *et al.*, 2012) [4]. In another study on 28-day-old pigeons, the length was reported as  $3.70 \pm 0.122$  cm (Nasrin *et al.*, 2012) [10]. The circumference of the proventriculus at the cranial, middle, and caudal parts had mean values of  $2.10 \pm 0.04$  cm,  $2.48 \pm 0.06$  cm, and  $2.71 \pm 0.12$  cm, respectively. The analysis of variance (ANOVA) indicated that there were significant differences in the circumference among the cranial, middle, and caudal parts. In frizzled feather and naked neck fowl, the circumference (external diameter) of the proventriculus at the cranial, middle, and caudal parts was reported as  $3.51 \pm 0.20$  cm,  $5.25 \pm 0.17$  cm, and  $3.80 \pm 0.21$  cm, respectively, and  $3.26 \pm 0.53$  cm,  $4.50 \pm 0.36$  cm, and  $3.53 \pm 0.33$  cm, respectively (Mal *et al.*, 2017) [5]. These measurements in frizzled feather and naked neck fowl were larger than those observed in the present study on pigeons, which could be attributed to the larger size of these fowl breeds compared to pigeons.

### Gizzard

**Gross anatomy:** The gizzard in pigeons was observed to be a highly muscular organ, resembling a biconvex lens-shaped disc (Figure 1). These findings are consistent with observations in chickens (McLelland, 1975) [6] and laughing doves (Al-Kinany, 2019) [1]. However, in *Elanus caeruleus*, the absence of an isthmus caused the gizzard and gizzard to combine into one large pear-shaped cavity (Hamdi *et al.*, 2013) [3]. The gizzard was located in the caudo-ventral region of the thoraco-abdominal cavity, situated between the gizzard and the duodenum (Figure 2). The cranial end of the gizzard made contact with the caudal end of the liver lobes, creating a deep impression, which is similar to observations in chickens (McLelland, 1991) [9] and laughing doves (Al-Kinany, 2019) [1]. The caudal end of the gizzard was related to the duodenum and pancreas (Figure 2, 3). The dorsal surface of the gizzard was associated with the testicles in males and the ovary in females, while the ventral surface was in contact with the abdominal floor on the left side and the liver lobe on the right side (Figure 2). These findings align with observations in chickens (McLelland, 1991) [9] and laughing doves (Al-

Kinany, 2019)<sup>[1]</sup>. The gizzard consisted of a body and two tapering ends known as the saccus cranialis and saccus caudalis (Figure 3). The walls of the gizzard were composed of thick muscles with an aponeurosis in the center (Figure 3, 4). The mucosa of the gizzard was lined by a greenish-brown membranous structure called koilin (Figure 4, 5), similar to the presence of a similar type of mucosa in laughing doves (Al-Kinany, 2019)<sup>[1]</sup> and guinea fowls (Saran *et al.*, 2019)<sup>[7]</sup>.

**Biometry:** The mean  $\pm$  SE values of the length, circumference, and maximum thickness of the gizzard in

pigeons were determined as  $2.48 \pm 0.03$  cm,  $7.78 \pm 0.11$  cm, and  $1.48 \pm 0.06$  cm, respectively. In comparison, the length of the gizzard in guinea fowls was reported as  $45.344 \pm 1.16$  mm, and the mean  $\pm$  SE value of the maximum thickness was  $24.452 \pm 0.41$  mm (Saran *et al.*, 2019)<sup>[7]</sup>. Both of these measurements in guinea fowls were considerably higher than those observed in the present study on pigeons. This difference can be attributed to the variation in size between the two bird species, with guinea fowls being larger than pigeons.

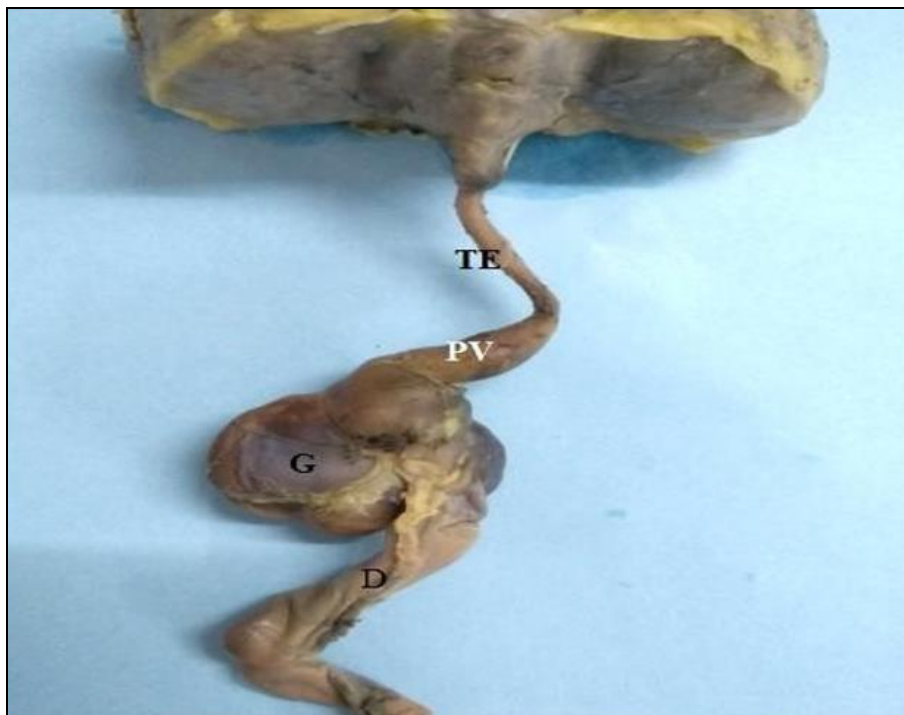


**Fig 1:** Gross photograph of stomach showing proventriculus (PV) and gizzard (G).

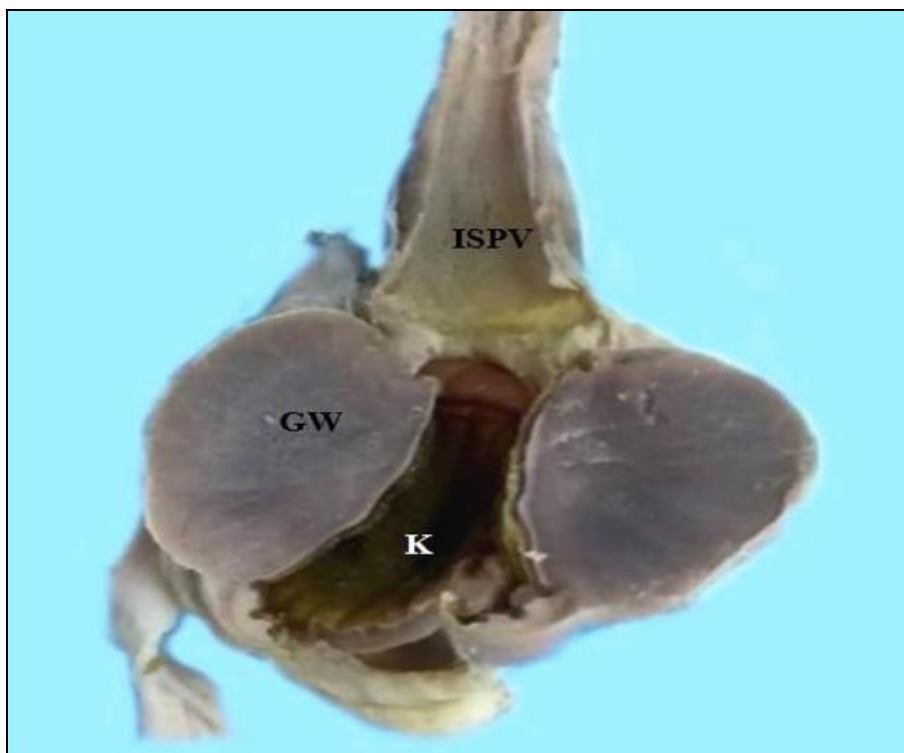


**Fig 2:** Gross photograph showing the proventriculus (P) located in between two bronchi (BR) on the ventral surface of the lung (L) and caudal end of the gizzard (G) related to the duodenum (D) and pancreas (P).

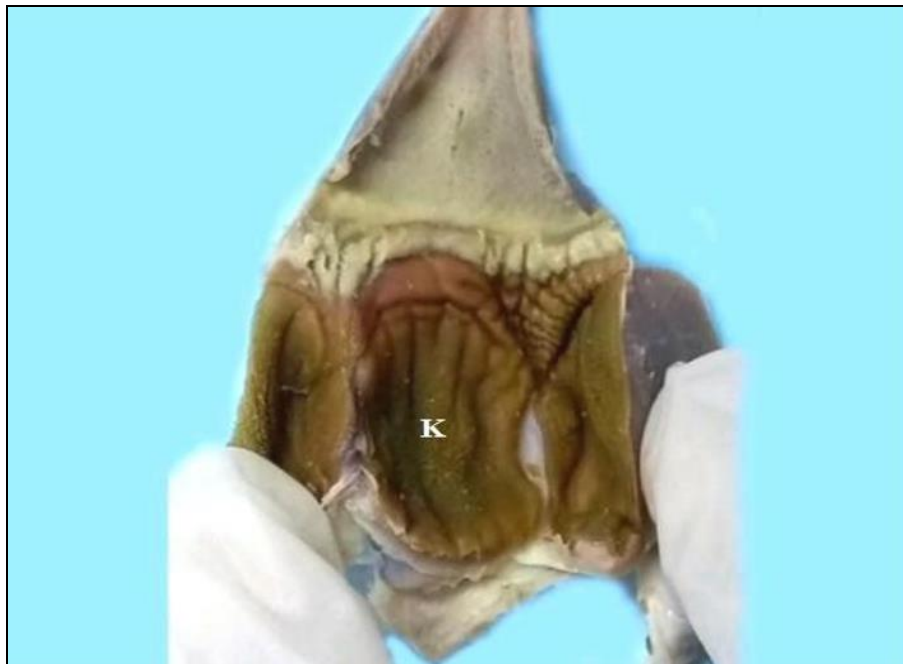




**Fig 3:** Gross photograph of proventriculus (PV) and gizzard (G) showing proventriculus cranially continued with thoracic oesophagus (TE) and gizzard caudally continued with duodenum (D).



**Fig 4:** Gross photograph of stomach showing mucosal surface of proventriculus (ISPV), gizzard wall (GW) and koilin (K).



**Fig 5:** Gross photograph of internal surface of gizzard showing koilin (K).

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