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Histological Studies on The Cecum and The Distal Part of Ileum in Quail with Special Reference to The Ileo-Ceco-Colic Junction

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Abstract

THE cecum of quail considered a good model for understanding the cecal physiology in domestic birds, namely the intestinal type. The aim of this study was to describe the histological structure of the distal part of ileum, and the cecum with special reference to the ileocecocolic junction. A total of twelv adult male quails were used in the present study. The distal ileum showed short villi, which became higher with deeper intestinal crypts at level of ilieocecocolic junction. The proximal cecum had long villus-like mucosal folds, and deep intestinal-like crypts. Cecal tonsils were observed near the cecal entrance. The distal cecum presented a peculiar microanatomic feature of internal sacculation, which may help in fermentation and absorption of digesta. A circular band of smooth muscles was found beneath the lamina propria-submucosa in both the ileum and cecum. This band may work as a sphincter muscle that regulate the passage of digested substances. In conclusion, the distal ileum and cecum in quails showed several adaptations that may play a role in regulating the fermentation and absorption process, as well as the passage of digesta.

Keywords: Cecum, Quail, Cecal tonsils, Ceco-colic junction, large intestine.

Introduction

The avian cecum is a multi-purpose organ, with the potential to act in many different ways and depending on the species involved, its cecal morphology, and ecological conditions, cecal function can be efficient and essentially important to a bird's physiology, especially during periods of stress [1].

The avian ceca classified according to Naik [2] followed by McLelland [3] into five histological types, as follows: Intestinal type in which the ceca are long and histologically similar to the small intestine, observed in galliforms (fowl, quail), ratites (ostrich), diving birds (loons, Grebe) and cuckoos; Glandular form which presented long and well-developed ceca with an abundance of goblet cells and capable of profuse secretary activity seen in owl; Lymphoid type, having small ceca with many lymphocytes aggregations present in pelican, heron, eagles and sparrow; Vestigial type, present in penguin but absent in pigeons, parrots, swifts and hummingbirds.

Gallinaceous ceca, and the quail ceca, in particular are the best model of the intestinal cecal type, and the most popular type of bird's cecum [4]. Moreover, Quails are increasingly used of recent as experimental model due to their rapid development, small size and affordable cost [5]. For these, the

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morphological studies concerning the quail ceca are critical in comprehensive understanding of the cecal functional role and ultimately the bird's physiology.

Gross investigations established that the gallinaceous ceca, including the quail ceca had a proximal part or base, and a distal part or apex [6]. The aim of this study was to describe in details the histomorphological structure of each of the aforementioned parts with special focus on the ceco-colic junction, and the distal part of ileum, in-order to highlight and discuss their different functional roles. These morphological details, may also act as a base for further investigations concerning seasonal, ecological, nutritional changes and etc. in the histology of quail ceca.

Material and Methods

Samples

This study was performed following the ethical guidelines approved by the Institutional Animal Care and Use Committee of the Faculty of Veterinary Medicine, Benha University. A total of 12 pairs of ceci and distal parts of ileum were harvested from the bird's cadaver immediately after slaughter. Twelve apparently healthy adult Quails were used for this study. They were obtained from the farmers and farms located in El-Qalyobia, Egypt. Congenital or pathological abnormalities of the digestive tract were considered exclusion criteria for studying the histological features of ileum and cecum in Quails.

Histological examination

The samples were collected and immersed in 10% neutral buffered formaldehyde solution. The fixed specimens were dehydrated in ascending grades of ethyl alcohol, cleared in several changes of xylene, impregnated and embedded in paraffin wax. The tissues were blocked and 5-7 µm thick sections were cut using a rotary microtome. The general histological observations were carried out on paraffin sections stained with haematoxylin and eosin (H&E). Mallory Trichrome staining technique was also performed [7].

Results

The histological layers of the distal ileum and the cecum in quail were arranged from the innermost layer (luminal) toward the outermost one as follows; the lamina *epithelialis* mucosa, the lamina propria blended with the submucosa due to the absence of lamina muscularis mucosa, thus, forming lamina propria-submucosa; tunica muscularis, and tunica serosa.

In the distal part of ileum, the lamina epithelial layer was formed by a simple columnar epithelium with goblet cells (Fig 1a, b). The epithelium itself was thrown into stout villi-like projections having deep infoldings; the crypts of Lieberkühn (glandular crypts), the later extended into the lamina propria sub mucosa (Fig 1a, b). Near and at the ileocecocolic junction, the villi-like projections became higher, with deeper glandular crypts (Fig 1 b). Tunica muscularis formed a complete circular band just beneath the lamina propria submucosa (Fig 1 a, b). Tunica serosa was formed by adipose connective tissue rich in blood vessels (Fig 1a, b).

The proximal part of the cecum, which opened into the lumen of colon (rectum), with the cecal entrance presented intestinal like feature. It had a long (high) finger-like villi, with deep intestinal crypts (Fig 2a). The epithelial layer lined with simple columnar epithelium with goblet cells (Fig 2a-c). Some goblet cell clusters were also observed within the luminal epithelium (Fig 2a). The lamina propria-submucosa was of loose connective tissue, rich in blood vessels and heavily infiltrated with lymphoid cells, especially at the core of cecal villi (Fig 2a-c). The tunica muscularis presented a continuous circular inner band of smooth muscle bundles, and an outer longitudinal one (Fig 2a-c). The tunica serosa continued with that of ileum and had the same adipose rich structure (Fig 2a-c). The core structure of the villi as well as the Subjunctive muscular layers were clearly visible with Mallory Trichrome (Fig 3a, b).

The distal part of cecum showed special feature, which included, the presence of two types of cecal villi; high villi, and short (stout) ones. The short villi were arranged in between the high ones forming internal sacculation's; a basal circular band that was especially thicker beneath the stout villi (Fig 4a, b). The lamina propria within the core of the higher villi was filled by adipose tissue rich in blood vessels. This adipose tissue was well sited as a fat pad within the villi core, making it standing higher, forming the lateral wall of internal saccules (Fig 4a, b). These features were clearly elucidated in the Mallory Trichrom-stained sections (Fig 5a, b)

The mucosal associated lymphatic tissue was extensive in the distal part, with large lymphoid follicles bulged beneath the lamina *epithelialis* i.e., cecal tonsils (Fig 6). The epithelium where these cecal tonsils were located were free of cecal villi (Fig 6).

Discussion

The histological structure of the ceca in *galliforms* species such as fowl, turkey and quail are hard to distinguish from that of the other parts of small intestine [1]. Although bird's ceca were formed basically of three layers mucosa, musculosa (muscularis) and serosa, they however differ in the abundance of lymphoid and glandular tissue as classified according to Naik [2] followed by McLelland [3] into four histological types, intestinal, glandular, lymphoid and vestigial. The intestinal type is represented in galliformes as the glandular and lymphoid tissue are similar to that of small intestine,

in particular, the ileum. The glandular type is found in owl, it has an abundance of goblet cells and capable of profuse secretory activity. Lymphoid aggregations are dominant and well developed in the lymphoid ceca which present in pelican, heron, eagles and sparrow. The cecum is reduced or vestigial in penguin and pigeons and it was ill-developed or absent in parrots, swifts and hummingbirds. The quail cecum is a good model for understanding the intestinal type in terms of size, and fermentation rate [8, 1].

This study described the structure of distal cecum in quail which differ from that of its proximal part. The histology of proximal cecum resembled those of distal part of ileum, both had intestinal like villi, but the proximal cecal villi was longer, and heavily infiltrated with lymphoid tissue, namely cecal tonsils. This information was in agreement with those described in Quail [9, 10], geese [11], pigeon [12], chicken [13]), in sea ducks [14], in cattle egrets [15], in Guinea fowl [16], *Kadaknath* fowl [17], and in turkey [18]. These histological features of the proximal cecum, including the long villus like mucosal folds, and presence of cecal tonsils, may have a guarding immunological function, especially at the ileocecocolic junction [1, 12].

On the other hand, the distal cecum showed special arrangement of internal sacculation, which may play a role in providing the room required for fermentation process [8]. The circular smooth muscle band may work as a sphincter muscle, which control the passage of food from the ileum into the ceco-colic junction, and prevent regurgitation of digesta [1]. Generally, the functional histology of quail cecum can be discussed as follows; the digesta thought to be retained for longer periods in the cecum than in the other parts of intestinal tract. This is because the cecum is anatomically a blind ended sac, while the small and large intestine are opened tubes that allowed rapid movement of food substances [1]. Accordingly, the fluid substance has time to be absorbed, while the solid particles can be fermented by cecal flora [19]. Consequently, the cecum is a site of fermentation, and breakdown of cellulose, as well as, utilization, and absorption of water, and nitrogenous components.

Notably, the presence of mucosal associated lymphoid tissue in the form of heavy lymphatic infiltration, lymphatic follicles, and nodules is strongly suggested that the cecum as well as the ileum are sites of production of immunoglobulins, and antibodies [12].

Conclusion

Quail cecums are seen to be a useful model for comprehending domestic bird cecal physiology, specifically the intestinal type. Quails' distal ileum and cecum displayed a number of modifications that might be involved in controlling the process of fermentation and absorption as well as digesta transit.

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Declaration of Conflict of Interest

The authors have no conflict of interest to declare.

Ethical of approval

This study follows the ethics guidelines of the Faculty of Veterinary Medicine, Benha University, Egypt.

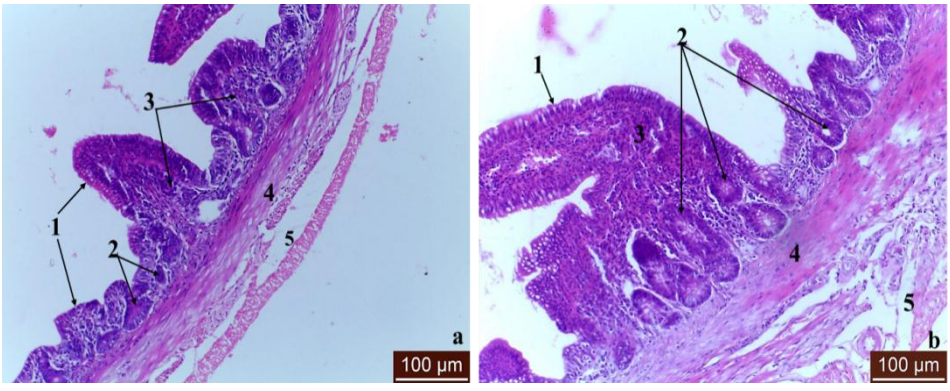

Fig. 1. A cross section in distal Ileum of quail near (a), and at (b) the ileocecocolic junction H&E stain, X 400, showing: lamina *epithelialis* (1), glandular crypts (2), lamina propria (3), tunica muscularis (4), Tunica serosa

rich in fat (5). Notice that the luminal epithelium showing stout villi (a), which become higher with deeper crypts at the ileo-ceco-colic junction (b).

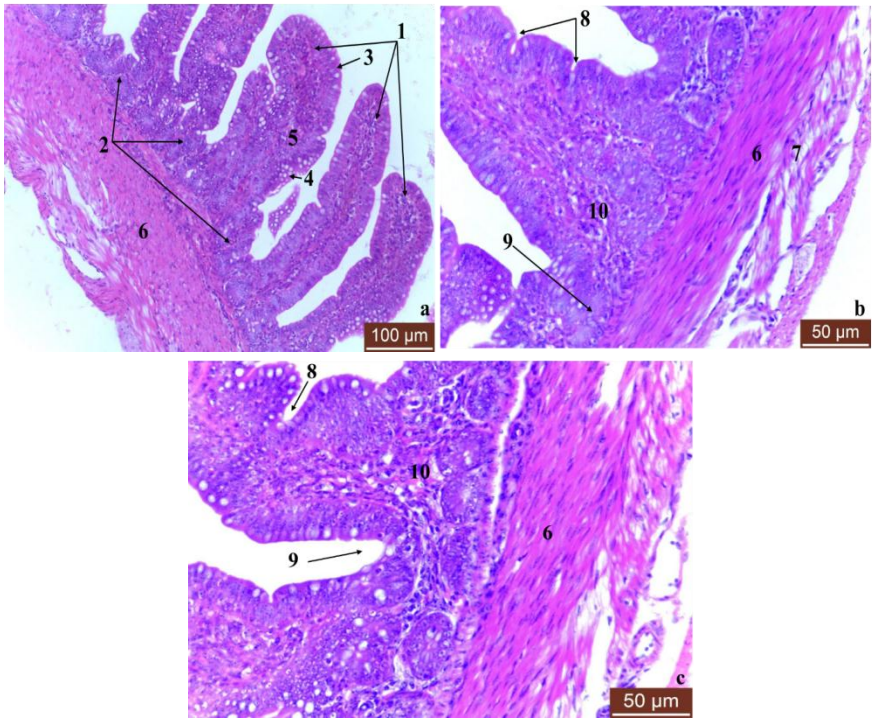

Fig. 2. A cross section of the proximal part of quail cecum, at the ilieocecocolic junction, H & E stain, X 200 (a), X 400 (b, c) showing A) the intestinal- like villi (1), and crypts (2), which lined by simple columnar epithelium with goblet cells (3), and goblet clusters (4), the lamina propria formed of loose connective tissue heavily infiltrated with lymphatic tissue(5), the tunica muscularis formed of an inner circular muscular band (6), with a thin outer longitudinally arranged muscles (7). B, C) the smaller glandular crypts (pockets) within the villi itself (8), and the larger crypts in between the villi (9), which extended to the lamina propria-submucosa (10).

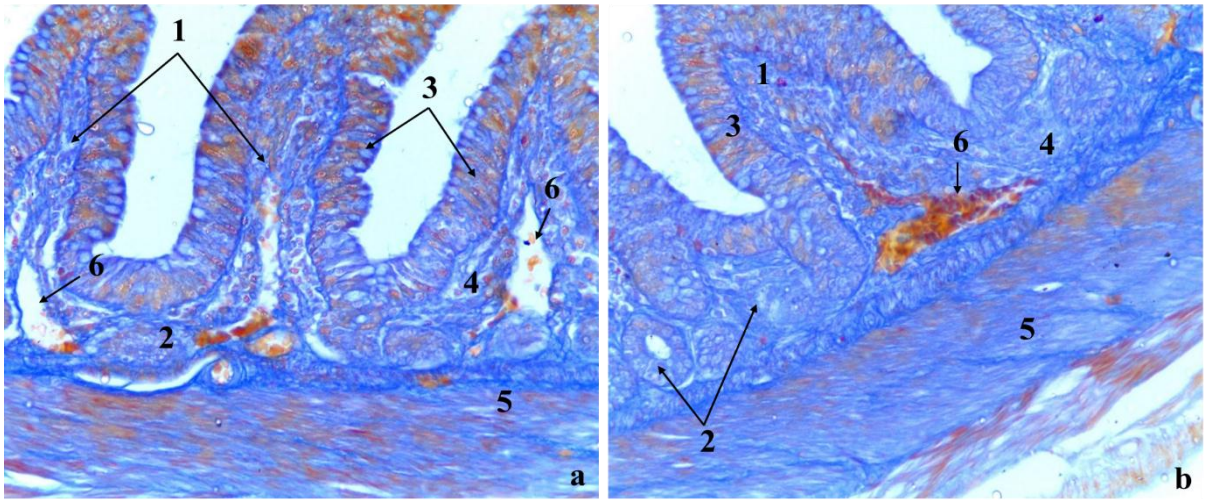

Fig 3. A cross section of the proximal part of quail cecum, at the ilieocecocolic junction, Mallory Trichrome stain, X 400, showing A, B) the intestinal- like villi (1), and crypts (2), which lined by simple columnar epithelium with goblet cells (3), the lamina propria (4), the tunica muscularis (5). Note that the lamina propria within the base of the villi was rich in blood vessels (6).

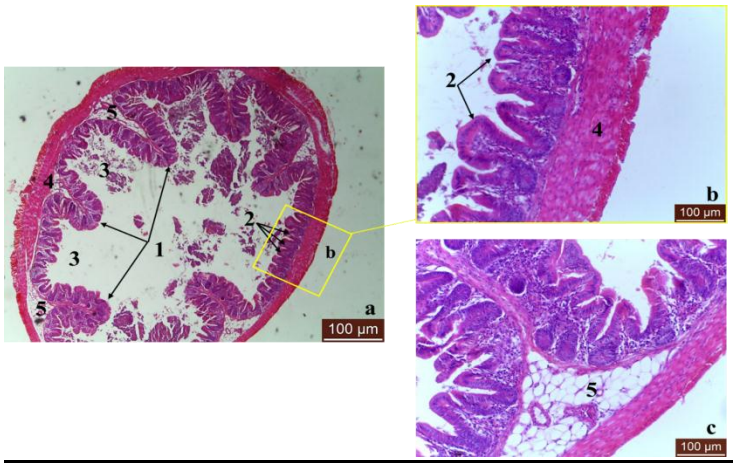

Fig 4. A cross section of the distal part of the quail cecum, H&E stain, X 40 (a), **X 400** (b, c) **showing A) the long (high) intestinal- like villi (1), and the short (stout) ones (2), which together forming a characteristic internal sacculation (3), the tunica muscularis (4), forming a complete circular basal band, which is especially thick basal to the short villi. B) the stout intestinal villi, which located in between the long villi, and forming together the floor of internal saccules C) Note that the lamina propria within the base of the high villi padded with adipose tissue (fat pad) that may keep these villi standing higher than the others (5).**

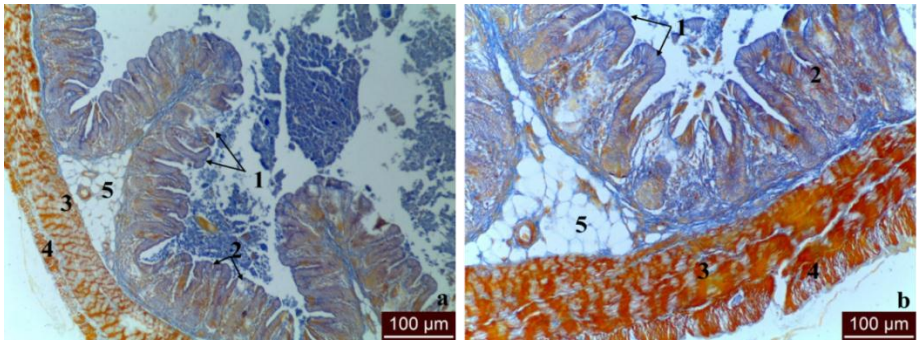

Fig 5. A cross section of the distal part of the quail cecum, Mallory Trichrome stain, X 400 showing A, B) the high intestinal- like villi (1), and the short ones (2), the tunica muscularis arranged into an inner circular layer (3), and an outer longitudinal one (4). Note the fat pad rich in blood vessels within the basal core of high villi fat pad (5).

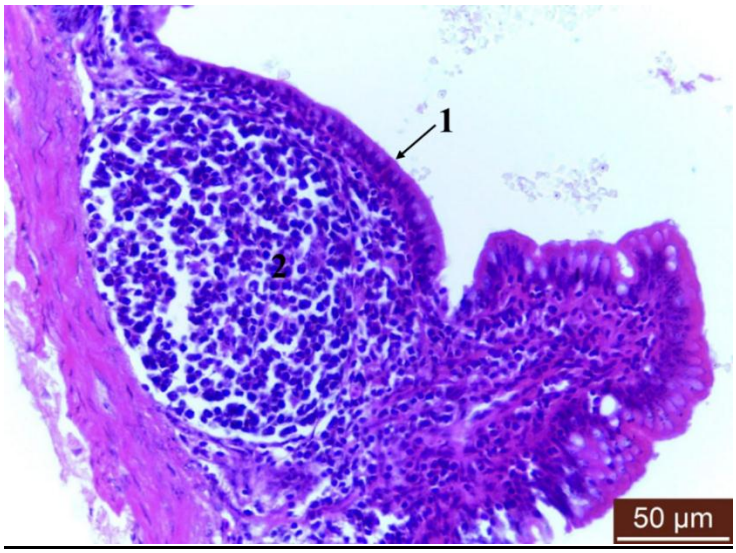

Fig 6. the cecal tonsil found in the proximal part of cecum near its entrance, H&E stain, X 400, notice that the luminal epithelium (1) above the cecal tonsils (2) did not form any crypts. The tonsils were formed of a follicular aggregation of lymphoid

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دراسات نسيجية على الأعور واللفائفي البعيد في طائر السمان (*Coturnix coturnix*) مع التركيز بشكل خاص على الوصلة اللفائفية-الأعورية-القولونية

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الملخص

يُعتبر الأعور لدى السمان نموذجًا جيدًا لفهم فسيولوجيا الأعور في الطيور الداجنة، وتحديدًا النوع المعوي. هدفت هذه الدراسة إلى وصف التركيب النسيجي للفائفي البعيد والأعور مع التركيز بشكل خاص على الوصلة اللفائفية-الأعورية-القولونية. استُخدم في هذه الدراسة 12 طائر سمان ذكر بالغ. أظهر اللفائفي السفلي زغابات قصيرة، والتي ازداد ارتفاعها مع وجود تجاويف معوية أعمق عند مستوى الوصلة اللفائفية-الأعورية. أما الأعور العلوي، فقد احتوى على طيات مخاطية طويلة تشبه الزغابات، وتجاويف عميقة تشبه الأمعاء. ولوحظت لوزتان أعوريتان بالقرب من مدخل الأعور. تميّز الجزء السفلي من الأمعاء الدقيقة (الأعور) بتشريح دقيق غريب، إذ شكّل تكيسات داخلية، قد تساعد في تخمير وامتصاص المواد المهضومة. يوجد شريط دائري من العضلات الملساء أسفل الصفيحة المخصوصة تحت المخاطية في كلٍّ من الأمعاء الدقيقة والأعور. قد يعمل هذا الشريط كعضلة عاصرة تُنظّم مرور المواد المهضومة. في الختام، أظهر الجزء البعيد من الأمعاء الدقيقة والأعور لدى السمان تكيفات عديدة قد تلعب دورًا في تنظيم عملية التخمير والامتصاص، بالإضافة إلى مرور المواد المهضومة.

الكلمات المفتاحية: الأعور، السمان، اللوزتان الأعوريتان، الوصلة الأعورية-المغصية، الأمعاء الغليظة.