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HISTOMORPHOLOGICAL STUDIES ON THE ILEUM, CAECUM AND ASCENDING COLON IN MIXED BREED DOGS IN TRINIDAD

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Abstract. The anatomical and histological features of the ileum, caecum and ascending colon were studied in six adult apparently healthy mixed breed dogs. The ileum communicated directly with the ascending colon via the ileocolic opening where the ascending colon begun. The caecum appeared as a distinct coiled outpouching from the proximal part of the ascending colon. The fine openings of the lymphoid nodules were seen in the mucosal surface of the caecum and first part of the ascending colon. The intestinal glands of the lamina propria and the lymphoid nodules of the submucosa of the ileum in the male dog were fewer and smaller than that of the female. The mucosa of the caecum and the first part of the ascending colon of the female dog was thinner with more goblet cells and larger lymphoid nodules than that of the male dog. The mucosa of the last part of the ascending colon showed less goblet cells with more lymphoreticular tissue in between the intestinal crypts. The lymphoid structures of the ileum, caecum and ascending colon were lack of cortex and medulla as well as germinal centers.

Keywords: *Morphology, Intestine, lymphoid tissues, dog.*

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1. Introduction

The intestine of animals is important for digestion and absorption of food as well as immunological function. Maskell and Johnson (1993) stated that the intestinal absorption occurs in the jejunum (50%), in the ileum (40%) and in the large intestine (10%). Histomorphological structures of the ileum, caecum and colon vary in different domestic animals depending on food habits. Pathology of the gastrointestinal tract is one of the most common causes of illness in the dogs (Hall *et al*., 2005). Gut–associated lymphoid tissue (GALT) occurs in the intestine of domestic animals which generates immune response against infection of the alimentary tract (Kapoor & Singh, 2015). GALT is present in the entire intestine in form of solitary lymph nodules, which known as Payer's patches (Macdonald, 2003; Newberry, 2008). Caecum has enormous lymphoid nodules throughout its mucus membrane which are vital site for medicinal therapies and immune responses (Paul *et al.*, 2017). Several studies have been done on the Payer's patches in the dog (Atkins & Schofield, 1972), in the calves (Liebler, 1998; Kapoor & Singh, 2016), sheep (Reynolds & Morris, 1983; Yang *et al*., 2012), goat and cattle (Liebler & Pabst, 2006) and in the pig (Ch *et al*., 1979). Moreover, some studies were done in the caecum

of the dog (Abd-El-Hady *et al.*, 2013 and Paul *et al.*, 2017). There is no available data describing the histological structure of the intestine of mixed dogs, so the current work aimed to study the histomorphological features of the ileum, caecum and ascending colon in mixed breed dogs in Trinidad.

2. Materials and Methods

Ethical approval; CEC906/02/19 School of Veterinary Medicine, Faculty of Medical Sciences, The University of the West Indies, Trinidad and Tobago. A total of six apparently healthy adult mixed breed dogs (3 males and 3 females) were used for the current study. The dogs were obtained from euthanatized dogs from the Trinidad and Tobago society for the prevention of cruelty to animals (TTSPCA). The abdominal cavity was opened carefully by cutting through the abdominal muscles and the intestine was exposed. The ileum, caecum and ascending colon were carefully removed, then incised and the ingesta were removed. Gross photos of the intact and opened intestinal parts were taken using a Sony 12 megapixel digital camera (Sony Coporation, Japan). Samples from the ileum, caecum and ascending were taken, fixed in 10% neutral buffered formalin for 24-48 hours, washed in running water, dehydrated in ascending grades of ethanol, cleared in xylene and embedded in paraffin blocks. Sections of 5 µm thickness were prepared using a microtome and stained by hematoxylin and eosin for general histological examination (Culling *et al.*, 1985). The stained sections were detected at different magnifications under a light microscope (Olympus BX40 with an Olympus DP 15 megapixel digital camera) and photomicrographs were taken.

3. Results

The gross observations showed that the gut of the mixed breed dog followed the general structure found in all domestic mammals. It was divided into the small intestine consisted of the duodenum, jejunum and ileum and the large intestine consisted of the colon and rectum. The ileum was the last and shortest portion of the small intestine. It was located between the jejunum and large intestine. It joined the ascending colon in the right midabdomen with a distinct ileocolic sphincter. The cecum was outpouching from the proximal part of the ascending colon with a distinct cecocolic sphincter. It consisted of a base, body and an apex. The ascending colon begun at the ileocolic junction and coursed cranially as the ascending colon, where it turned to the left at the right colic flexure and then coursed transversely cranial to the root of the mesentery, as the transverse colon. The fine openings of the lymphoid nodules were seen in the mucosal surface of the caecum and first part of the ascending colon. (Figure 1 A&B).

The microscopic observations showed that the intestinal villi of the ileum of the dog were thrown into the lumen of the intestine. The villi were covered by columnar epithelium with goblet cells while the core of the villi was occupied by a huge number of immunocompetent cells. The surface epithelium of the ileum was invagenated into the under lying lamina propria forming intestinal crypts lined by columnar cells with many goblet cells. The tunica submucosa was wide and occupied by many rounded or oval lymphoid follicles and diffused form of lymphoreticular tissue. The follicles sometimes penetrated the muscularis mucosa toward the lamina propria. The tunica muscularis appeared as two layers of smooth muscle fibers arranged as inner circular and outer longitudinal (Figure 2C). The intestinal villi of the male dog appeared longer

and fewer than that of the female. Also the intestinal gland of the lamina propria and the lymphoid nodules of the submucosa were fewer and smaller than that of the female (Figure 2D). At the junction of ileum and colon in both male and female, the intestinal villi and lymphoid nodules were gradually decreased till disappeared toward the colon (Figure 3E).

The wall of caecum of the male dog consisted of the mucosa, submucosa, muscularis and serosa. The tunica mucosa was formed of single layer of columnar epithelium with many goblet cells. Similar cells were noticed to line the intestinal crypts (Figure 4F). The interstitial tissue between the intestinal crypts was occupied by well-developed lymphoreticular tissue distributed among the crypts. Also many blood vessels (Figure 4G). The lamina muscularis mucosa thin layers of smooth muscle fibers, while the tunica submucosa showed well developed large lymphoid nodule (Figure 4F). In the female dog, the caecum had more goblet cells (Figure 4H). Also the submucosa lymphoid nodules became larger in size and sometimes extended to the mucosa through the muscularis mucosa to form lymphoglandular complex (Figure. 4I).

The wall of the ascending colon of male and female dogs was composed of the tunica mucosa, submucosa, muscularis and serosa. The colon was lined by a simple high columnar epithelium with a huge number of goblet cells. The mucosa showed long tubular crypts or invaginations (the intestinal crypts). The lamina muscularis mucosa was formed of two thin layers of smooth muscle fibers arranged as inner circular and outer longitudinal. The submucosa of male colon was formed of thick layer of fibro elastic connective tissue containing blood vessels, lymphatics and solitary lymphoid nodules as well as lymphoreticular tissue. The tunica submucosa of the female dog showed well developed large lymphoid nodule (Figure 5J & K). The mucosa of the ascending colon showed less goblet cells with more lymphoreticular tissue in between the intestinal crypts towards its last part (Figure 6L).

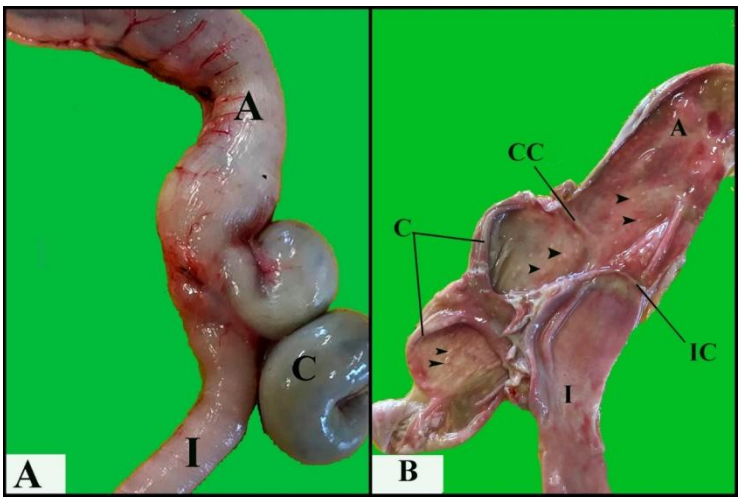

Fig. 1. Photographs showing the gross appearance of the intact (A) and incised ileum, caecum and ascending colon (B) of the mixed breed dog. A- Ascending colon; C- Caecum; CC- Caecocolic orifice; I- Ileum; IC-Ileocecal orifice; Black arrows- Openings of the lymphoid nodules and lymphoglandular complexes.

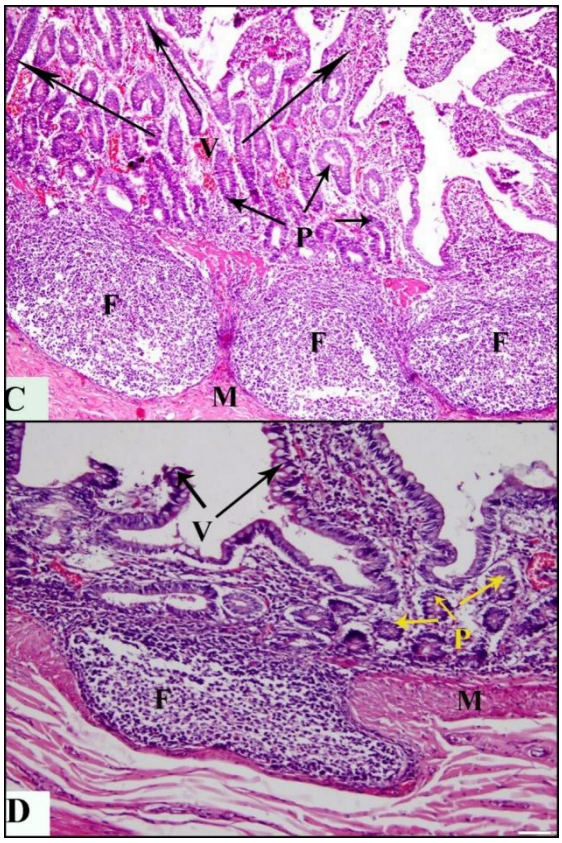

Fig. 2. Photomicrographs of the ileum of the female (C) and male (D) mixed breed dogs. V- Finger like to dome shaped intestinal villi; P- Intestinal crypts (fewer in the male); F- Lymphoid nodules occupied the submucosa; M- Smooth muscle. H&E stain, X10 for C & H&E stain, X20 for D.

Fig. 3. A photomicrograph at the junction between ileum and proximal part of the ascending colon (E) of the male mixed breed dog. V- Gradual disappearance of intestinal villi; F-Lymphoid nodules; M- Smooth muscle. H&E stain, X4.

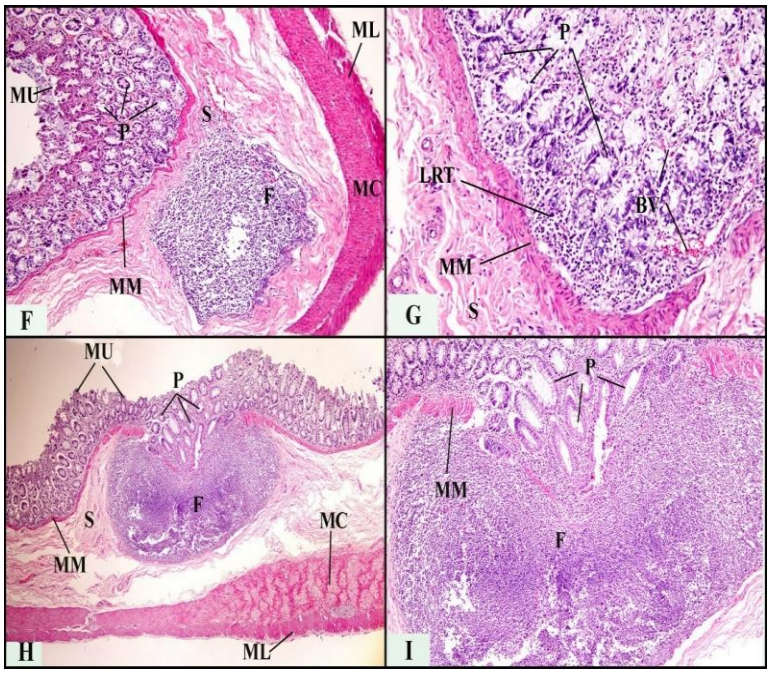

Fig. 4. Photomicrographs of the caecum of male dog (F) showing mucosa (MU) lined by simple columnar epithelium with many goblet cells. The intestinal crypts (P) showing huge number of goblet cells. Thin muscularis mucosa (MM).The submucosa (S) showed large lymphoid nodule (F). The Muscular coat, inner circular (MC) and outer longitudinal (ML). H&E stain.X10. A higher magnification of the caecum of the male dog (G) showing intestinal crypts (P) lined by numerous goblet cells while the interstitial tissue between the crypts occupied by well-developed lymphoreticular tissue (LRT) and many blood vessels (BV). H&E stain.X20. The caecum of the female dog (H) showing the caecal mucosa (MU) lined by high columnar with many goblet cells which also lined the intestinal crypts (P). The lamina muscularis mucosa (MM) and large lymphoid nodule (F) in the submucosa (S). H&E stain.X4. A higher magnification the caecum of the female dog (I) showing intestinal crypts (P) lined by high columnar epithelium with many goblet cells. Notice a well-developed muscularis mucosa (MM) and a large well developed lymphoid nodule (F). H&E stain.X10

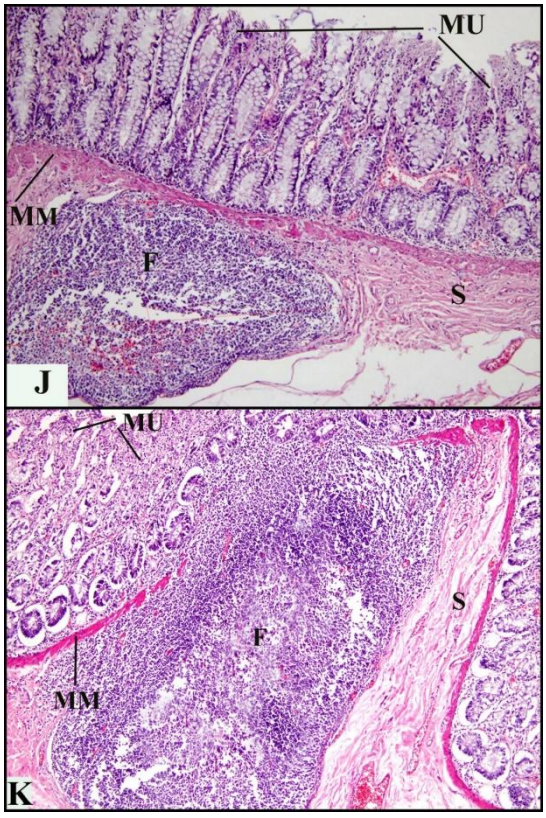

Figure 5. Photomicrographs of the initial part of the proximal colon of male (J) and female (K) mixed breed dogs showing tunica mucosa (MU) rich in goblet cells, lamina muscularis mucosa (MM) and tunica submucosa (S) containing lymphoid nodule (F). H&E stain, X10.

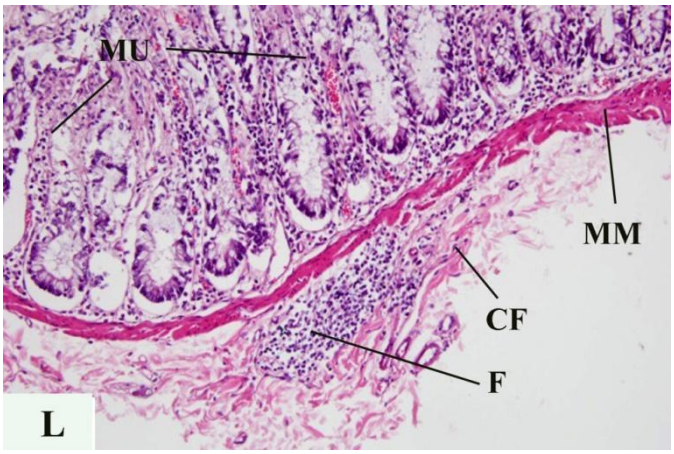

Fig. 6. A photomicrograph of the last part of the ascending colon of the female mixed breed dog showing tunica mucosa (MU) with fewer goblet cells, well developed muscularis mucosa (MM), and submucosa (S) containing lymphoid nodule (F) and collagen fibers (CF). H&E stain, X20

4. Discussion

There is not much available literature reporting on the histomorphological features and lymphoglandular complex of the ileum, cecum and ascending colon of the mixed breed dog in Trinidad, however, the caecum of the dog (Abd-El-Hady *et al*., 2013; Paul *et al.*, 2017) and the lymphoglandular complex of the large intestine of the dog (Atkins and Schofield, 1972) were described.

The fine openings of the lymphoglandular complexes and lymphoid nodules were seem grossly in large and small numbers in the mucosal surface of the caecum and first part of the ascending colon respectively; a similar result was reported in the large intestine of the dog (Atkins & Schofield, 1972; Abd-El-Hady *et al.*, 2013), while several small openings were found in the proximal colon of the buffalo calf (Kapoor & Singh, 2016). The mucosa of the caecum of the dog contained solitary lymph nodes, while these nodes are grouped at the tip of the organ in the cat (Damian *et al.*, 2012). The lymphoid tissue was visible as raised plaques on the mucosal surface of the ileum of the young horse (Lowden & Heathwart, 1995).

The wall of the ileum of the male and female mixed breed dogs contained lymphoid follicles; a similar result was found in the terminal part of the ileum of the fetal lamb (Renolds & Morris, 1983), in the fetal pig (Binns & Licence, 1985) and in the buffalo calves (Kapoor & Singh, 2015) and on the mucosal surfaces of the ileocecal orifice, the beginning of the cecum and the first third of the colon in the camel (Wang *et al.*, 2014).

The lymphoglandular complexes were seen numerous throughout of the length of the caecum of the mixed breed dog; a similar result was reported in the dog (Atkins & Schofield, 1972, Dellmann and Brown, 1981; Abd-El-Hady *et al.*, 2013) and in the goat (Sisson & Grossman, 1975; Dellmann & Brown, 1981; Kadem *et al.*, 2011; Gosh, 2013). While, the lymphatic nodules are present only at the apex of the caecum of the dog, distal part of the caecum of the pig and at the proximal part of the caecum of the goat in form of lymphocytes aggregations in-between the glands (Paul *et al.*, 2017).

The current study revealed that there were plenty of goblets cells in the crypts of the caecum of the male and female mixed breed dog; a similar result was reported in the dog and pig (Paul *et al.*, 2017). However, the goblets cells are absent at the fundus of the glands in the caecum of the dog (Atkins & Schofield, 1972).

The lymphatic nodules were seen in the ascending colon of the male and female mixed breed dog; a similar result was reported in the colon of the dog (Atkins & Schofield, 1972), in the proximal colon of the buffalo calf (Kapoor & Singh, 2016), in the ascending colon of the rat (Crouse *et al.*, 1989), in the colon of the Angora goat (Bayraktaroğlu *et al.*, 2016), in the colon of the pig (Morfitt, 1990) and in the in the proximal colon of the buffalo calf (Kapoor & Singh, 2016).

5. Conclusion

The fine openings of the lymphoid aggregations were seen grossly in the mucosal surface of the caecum and ascending colon. The lymphoid aggregations were seen microscopically in the ileum, caecum and ascending colon

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