Anatomical, Radiological and Endoscopic Angulations Studies on the Colon in Dogs *(Canis familiaris)*

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Abstract

The flexible gastrointestinal endoscopy is a non-invasive modality for the assessment, diagnosis of gastro-intestinal disorders and analysis of the tissues, cells and mucosa of the gastrointestinal tract. The utilization of this technique is for esophagoscopy, gastroscopy, duodensocopy and even colo-noscopy in conjunction with the corres-ponding anatomical relations. The present investigation was conducted on the apparently healthy three mongrel dogs that were brought to the surgery unit of the faculty of veterinary medicine, Cairo University and three other dogs were kept for normal anatomical dissection. This work illustrated the usage of anatomy, endoscopy and radiography in order to obtain an endoscopic image and simultaneously, take an x-ray film along the different parts of the colon. The study revealed that the colon of the dog has the simplest form, being divided into ascending, transverse, and descending parts and extending from the cecocolic opening to the cranial end of the rectum. Different angulations and directional changes in the colon of dog supported by the anatomical interpretations, the overall form and directions of the insertion tube during the colon examination were mentioned. This work aimed to presen a clear and detailed data of the normal endoscopy and the anatomy of the colon in addition to, providing an educational model for practical application of the endoscopic examination of the lower part of the gastrointestinal tract of the dog.

Keywords: Anatomy, Endoscope, Radio-graph, colon, dogs.

Introduction

Endoscopy is an effective and safe method for the diagnosis and treat-

ment of many gastrointestinal (GI) disorders, and should be used combined with other diagnostic tools (Moore, 2003).

Flexible GI endoscopy is a non-invasive significant modality for the investigation of the GI mucosa, diagnosis of several GI disorders in small animals (Zoran, 2001; Jergens et al., 2016; Eldessouky et al., 2019). Also, this diagnostic method permits the analysis of tissues, cells and/or fluids samples. The use of the GI endoscopy has been widely reviewed in small animal practice for early diagnosis of GI diseases and the interpretation of their pathophysiology. (Willard, 2001; Zoran, 2001; Mansell, Willard, 2003; Simpson, 2005; Spillmann, 2007; Chamness, 2011; Webb and Twedt, 2013; Marolf, et al., 2015 and Eldessouky et al., 2019).

The clinical and practical indications of the flexible GI endoscopy is for gastric and intestinal feeding tube placement, colonoscopy, duodenoscopy, gastroscopy, esophagoscopy, foreign body recover, biopsy (tissues and cells) samples from gastrointestinal mucosa, ballooning techniques for esophageal and colonic strictures and guided rectal and colonic polypectomy (Lecoindre, 1999; McCarthy, 2005; Simpson, 2005; Jergens, et al., 2011; Tams, 2011; Malancus, et al., 2012 and Webb and Twedt, 2013; Hall, 2015 and Eldessouky et al., 2019).

Radiography demonstrates the various angulations of the endoscope during gastroscopy (Tams, 2011 and Eldessouky et al., 2019).

Materials and Methods

This work was performed after the approval of the Institutional Animal Care and Use Committee of the faculty of Veterinary Medicine, Cairo University (Vet. CU. IACUC) Vet CU 08072023684.

1. **Animal selection:** This study was performed on six apparently healthy male mongrels dogs, 5-7 kg.b.w.t. Three out of six were chosen for normal anatomical dissection while the remaining three dogs were kept in the experimental unit of Surgery, anesthesiology and radiology department, Faculty of Veterinary Medicine, Cairo University.

2. **Anatomical study:** three dogs were euthanized and preserved in a mixture (10% formalin, 4% phenol. 1% glycerin) for fixation then left for 3 days in a cold room (Hildebrand, 1968) before dissection. The nomenclature used in this study was adopted according to Nomina Anatomica Veterinaria (2017).

3. **Imaging system:**
   a) ***Endoscopy***: the endoscopic images were taken for the colon of the investigated dogs

using Eickemeyer video-endoscope unit associated with halogen light source (Vet Lux-150 Watt) and insertion tube (8.5 mm diameter, 1.5-meter length and 2 mm working channel).

b) ***Radiograph:*** by using Fischer x- ray unit, the radiographic factors were ranged from 44-60 KV; 100 mAs at 0.1 second and 100 FFD for lateral view and from 46-65 KV; 100 mAs at 0.1 second and 100 FFD for ventrodorsal view.

4. **Animal preparation for endoscopy:** for the lower digestive tract endoscopy**,** each of the remained three dogs was fasted 24 hours before colonscopy. Then each dog was laid down in right lateral recum-bency.

5. **Anaesthesia for endoscopy:** each dog had been given atropine sulpha te (1%®, 0.05-0.1mg /kg.b.wt. Adwia Co.S.A.E- Egypt) and xylazine (Xyla-Ject 2%®, Adwia co.S.A.E- Egypt 1mg/ kg.b.wt.) to ensure tranquilization and muscle relaxation. Anaesthesia was stimulated using ketamine HCL (Ketamine®, 10-15mg /kg. b.wt. Sigma-Tec, Egypt) or diprivan 1% emulsion (Propofol® 2mg/ kg.b.wt. Astrazeneca, U.K) and maintained by ketamine HCl (Mckelvey and Hollingshead, 2000).

Results

A. Colon Anatomy

The large intestine of dog is a simple tube that lacks both sacculations (haustrae) and teniae with larger diameter than that of the small intestine.

The cecum (fig.1, 2/cm) appeared as a twisted blind ended diverticulum from the initial part of large intestine and communicated with colon through cecocolic opening (fig. 2/J) apart from ileocecal opening by approximately 1 cm.

The colon has the simplest form, being divided into ascending, transverse, and descending parts and extending from the cecocolic opening to the cranial end of the rectum. The colon is approximately 2 cm in diameter, 30 cm in length and situated in the dorsal part of abdominal cavity.

Colon ascendens: the ascending colon (fig.1, 2/ CA) is situated on the right side of the abdomen, runs cranially beginning from the ileocolic opening (fig.2/J) and ends cranially at the right colic flexure (fig.1, 2/fcd) (hepatic flexure). It is approximately 7 cm long and lies ventral to the right kidney and dorsal to small intestine. Cranially, the ascending colon form nearly right angle and directed to the left side caudal to the left medial lobe of liver.

Colon Transversum: the transverse colon (fig.1, 2/CT) is approximately 8 cm. long with the shape of slight arc, It passes from the right to the left side of the abdomen, forming the right colic flexure of the ascending colon to the

left colic flexure (fig. 1, 2/fcs) (splenic flexure) of the descending colon. It is placed transversely, cranial to the cranial mesenteric artery and is related cranially to the stomach and dorsal to the coils of the small intestine.

Colon Descendens: the descending colon (fig.1, 2/CD) is the longest segment of the colon. It extends from the left colic flexure cranially up to the pelvic inlet caudally, where it continues as the rectum (fig. 1, 2/R) without anatomical demarcation. It is approximately 12 cm. long. It follows the curvature of the left lateral abdominal wall from the left costal arch to the level of the promontory of the sacrum. It is in contact at its beginning with the ventral surface of the left kidney and dorsal to the intestinal coils.

B. Colonoscopy.

Firstly, the endoscope was advanced through the rectum and descending colon then the tip slightly made a directional change till the tip became upward at 90-degree in which a partial fold, or splenic flexure was encountered on the left side of the abdomen then lateral radiographs with the endoscope tip was captured (Fig. 3a) showing the smooth mucosal surface of the descending colon and the endoscopic view of splenic flexure as demonstrated in (Fig. 3b). The endoscopic tip passed for 5–8 cm, the length of the transverse colon till the hepatic flexure was traversed. At this time lateral radiographs with the endoscope tip were captured at the entrance of the hepatic flexure (Fig. 3c) with the endoscopic view of this flexure as illustrated in (Fig. 3d).

After that the tip of the endoscope passed this flexure by deflection in a dorsal direction at less than 90 degrees to reach the ascending colon. Lateral radiographs with the endoscope tip situated at end of the ascending colon as shown in (Fig. 3e), in combination with the endoscopic view of the ascending colon as demonstrated in (Fig.3f) exhibiting the smooth mucosal surface of this colon. Lateral radiographs with the endoscope tip situated in the entrance of the ileocolic junction as shown (Fig. 3g), with the view of this part as shown in (Fig.3h) displaying the ileocolic opening supported by sphincter muscle. Lateral radiographs with the endoscope tip situated in the ileum as shown in (Fig.3i), in conjunction with the endoscopic view as displayed in (Fig.3j) illustrating the ileal mucosa.

Discussion

In the present work, there were definite directional changes up to 90 degree dorsally and ventrally during the colonoscopy to pass the splenic and hepatic flexures respectively in accordance to (Leib, 2010; Hall, 2015) who explained the endoscope was advanced through the rectum and descending colon till a

partial fold, or splenic flexure was encountered on the left side of the abdomen; the tip became upward at 90-degree and then passed to the 5–8 cm length of the transverse colon. Then moved slowly through the transverse colon till the hepatic flexure was reached, and after that the tip crossed this flexure by deflection in a dorsal direction at less than 90 degrees to reach the ascending colon.

The mucosa of the large intestine is generally smooth and the submucosal blood vessels are visible, a finding which is in agreement with Lecoindre (1999) ; simpson (2005) and Dyce, et al.(2010) who stated that there are visible submucosal blood vessels and smooth surface because villi are lacking. On the other side, the rectum appeared as a folded mucosa with tiny pits which agreed the findings of Dyce, et al. (2010); Leib (2010) and Hall (2015). There are numerous scattered lymph nodules, especially in the rectum, where they tend to be conspicuous; this is because the summits of the swellings are here depressed, leading to tiny pits.

Conclusions

This study explained and illustrated the various angulations during the investigation of the lower part of the gastrointestinal tract (Colon) using a revolutionary diagnostic tool (flexible gastrointestinal endoscopy) and with the assistance of the anatomical and radiographic examinations. The study would benefit and improve the skills of the endoscopist in the practical application of the endoscopic examination of the colon thus, avoiding perforation or injury of the gastrointestinal walls.

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Conflict of Interest

The authors declare no conflict of interest in preparing this work.

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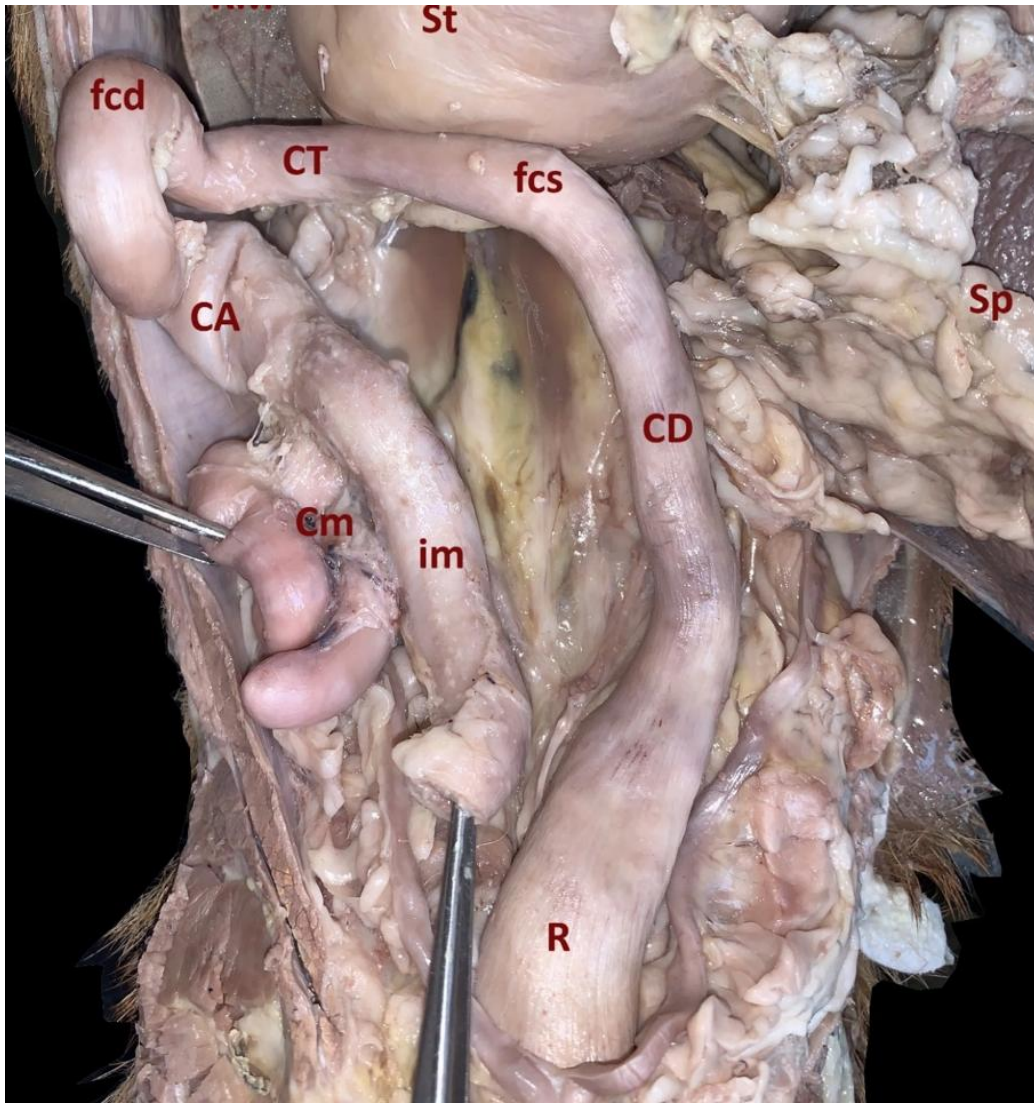

Fig.1 Anatomical external features and course of the colon in dog.

Im ileum, cm cecum, CA colon ascendens, fcd flexura coli dextra, CT colon transversum, fc flexura coli sinistra, CD colon descendens, R rectum, St stomach, Sp spleen.

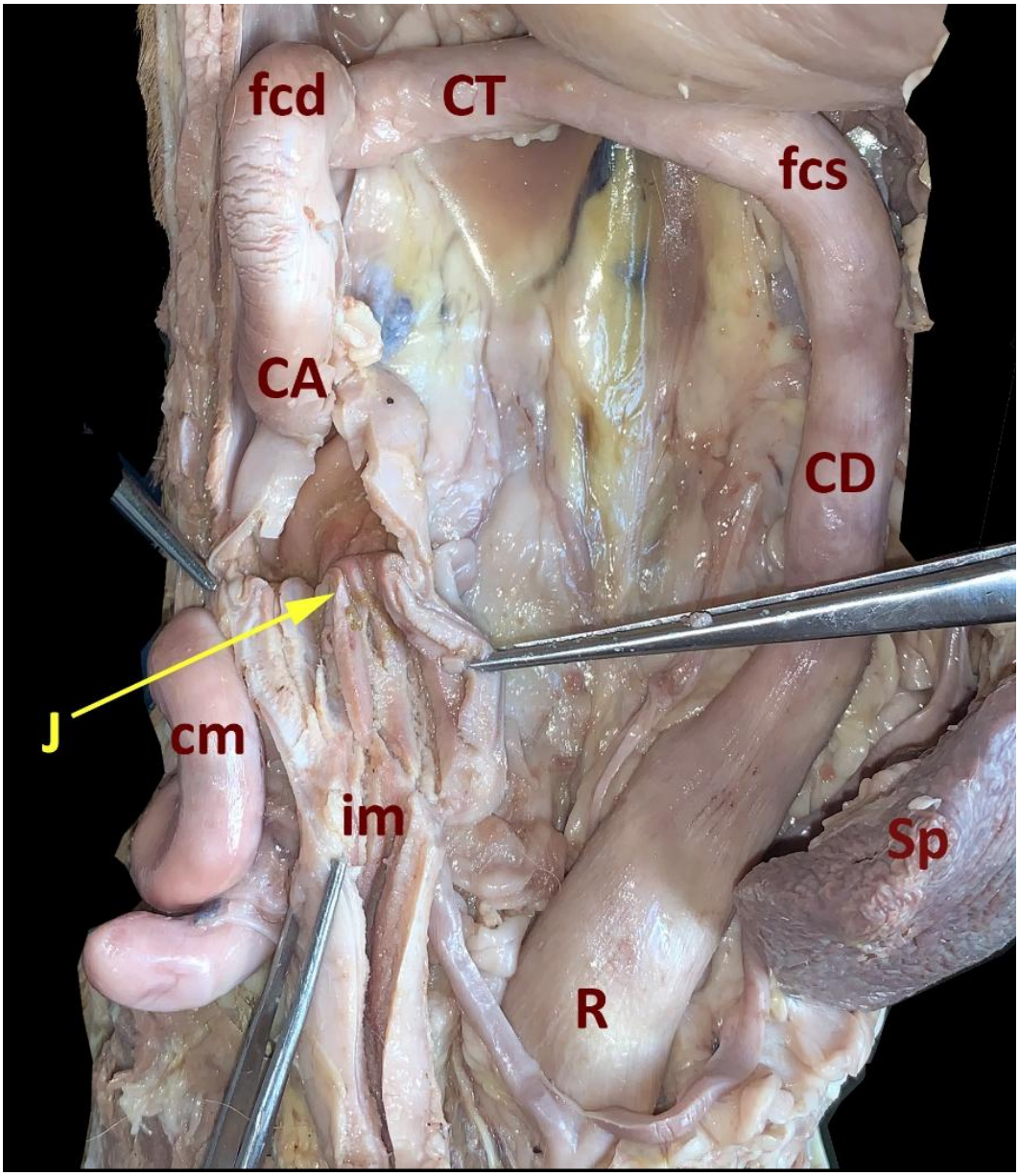

Fig. (2): Internal features of the ileal wall and the commencement of the colon in dog (ileum and colon are opened).

Im ileum, cm: cecum, CA colon ascendens, fcd flexura coli dextra, CT colon transversum, fcs flexura coli sinistra, CD colon descendens, R rectum, Sp spleen J ileocolic junction.

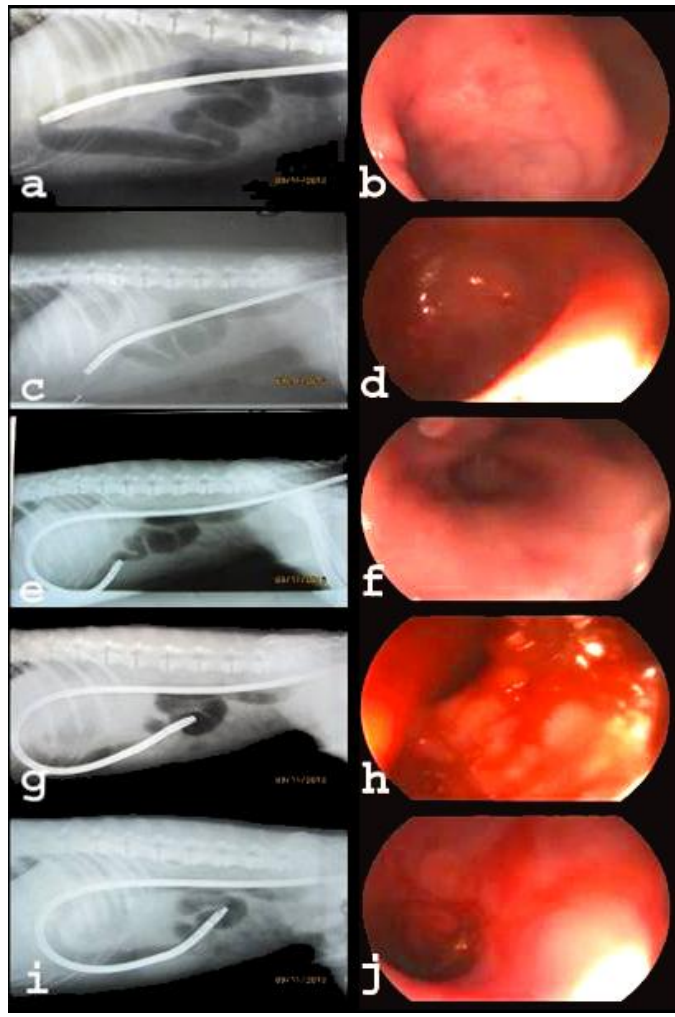

Fig. (3): Radiological and endoscopic depictions during colonoscopy.

a. lateral view radiograph with endoscope tip at splenic flexure.
b. the endoscopic view of the splenic flexure.
c. lateral view radiograph with endoscope tip at hepatic flexure.
d. the endoscopic view of the hepatic flexure.
e. lateral view radiograph with endoscope tip at end of the ascending colon.
f. the endoscopic view at end of the ascending colon.
g. lateral view radiograph with endoscope tip just passing the ileocolic junction.
h. the endoscopic view at ileocolic junction.
i. lateral radiograph with endoscope tip at ileum.
j. the ileal wall.