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MORPHOLOGICAL STUDIES ON THE COLON AND RECTUM OF SOME DOMESTIC ANIMALS WITH SPECIAL REFERENCE TO THE END FORM OF THE FECAL MATTER

(With 2 Tables, 5 Plates and 1 Hist.)

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دراسات مورفولوجية على القولون والمستقيم فى بعض الحيوانات المستأنسة مع اشارة خاصة للشكل النهائى للمادة البرازية

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أجريت هذه الدراسات على عدد خمسة عشر من كل من الكلاب والماعز والحمير من كلا الجنسين ومختلف الأعمار. أوضحت الدراسة أن طول الأمعاء الغليظة تراوح ما بين ٣٦,٣ و٥٩,٢ سم فى الكلب ، ٢٨٤ إلى ٤١٢ سم فى الماعز و٥١٢ إلى ٥٧٧ سم فى الحمار. وبلغ طولها ٠,٧٣ ، ٣,٩٥ ، ٣,٧٥ مرة طول الجسم فى الحيوانات الثلاثة المذكورة. بلغت نسبة القولون الصاعد ٦,٧%، ٧٤,٢% و٤٥,٦% من الطول الكلى للأمعاء الغليظة فى الكلب والماعز والحمار على التوالى ، بينما كانت نسبة القولون المستعرض ١٥% ، ٢,٦٧%، ٢,٣% فى الحيوانات المذكورة. وكانت نسبة القولون الهابط من الطول الكلى للأمعاء الغليظة ٢٥,٩% ، ١١,٣% و٢٩,٨% فى الكلب والماعز والحمار على التوالى. كما لوحظ وجود شريط واحد أو شريطين بجدار القولون المستعرض فى الحمار. أظهر السطح المخاطى للقولون فى الكلب وجود طيات طولية كبيرة وصغيرة متداخلة، اما فى الماعز تكون الطيات الطويلة غير متطورة فى القولون الصاعد، ومتطورة فى القولون المستعرض والهابط، وفى الحمار تميز السطح المخاطى بوجود الطيات المستعرضة فى القولون المستعرض والطيات الهلالية فى القولون الهابط. بلغت نسبة المستقيم والقناة الشرجية ٢٧% ، ٥,٧% و٥,٩% من الطول الكلى للأمعاء الغليظة فى الكلب والماعز

والحمار على التوالى. أظهر السطح اللمعى للمستقيم الفارغ فى الكلب وجود طيات طولية.كما أظهرت مخاطية المستقيم انطباعات الحبيبات البرازية فى الماعز أو الكرات البرازية فى الحمار التى انفصلت عن بعضها بواسطة طيات عرضية. وقد لوحظ أن الشكل النهائى للمادة البرازية (عمود فى الكلب، وكرات فى الحمار) تكون فى القولون الهابط فى كلأهما، اما فى الماعز فتظهر فى صورةحبيبات برازيةعند بداية التلافيف النابذة للقولون الصاعد.

SUMMARY

The macromorphology of the colon and rectum were carried out on 15 dogs, 15 goats and 15 donkeys of both sexes and different ages. This study revealed that the length of the large intestine was about 36.3 to 59.2 cm, 284.0 to 412.0 cm and 510.0 to 577.0 cm in the dog, goat and donkey, respectively. It formed 0.73, 3.95 and 3.75 times the length of the body in the before mentioned animals, respectively. The ascending colon constituted about 6.7% in the dog, 74.2% in the goat and 45.6% in the donkey, whereas the transverse colon formed about 15%, 2.67% and 2.3% in the same animals, respectively. The descending colon of the donkey formed about 29.8% of the total length of the large intestine, whereas in the dog and goat it constituted about 25.9% and 11.3%, respectively. The mucosal surface of the colon showed intermingled small and large longitudinal folds in the dog. In the goat, the longitudinal folds were either ill-developed at the ascending or well-developed at the transverse and descending colon. In the donkey, the mucosal surface was characterized by the presence of transverse folds in the transverse colon and semilunar folds in the descending colon. The rectum and anal canal comprised about 27%, 5.7% and 5.9% in the dog, goat and donkey, respectively. In the dog, the luminal surface of the empty rectum showed longitudinal folds at its cranial part and transverse ones at the rectal ampulla, in addition to numerous mucosal pits. While, the rectal mucosa of the goat and donkey, demonstrated longitudinal folds in addition to the Columnae rectales at its caudal part in the former animal. In distension the rectal mucosa showed impressions of fecal pellets (goat) or fecal balls (donkey), which were delineated by transverse folds. The end form of the fecal matter (column in dog and balls in donkey) was formed in the descending colon. However, in the goat, the pellets appeared at the beginning of the centrifugal gyri of the ascending colon.

Key Words: *Morphology, colon, rectum, dog, goat, donkey, fecal matter*

INTRODUCTION

The colon exhibits large morphological interspecies variations, these variations are believed to be at least partly related to the diet (Christensen, 1972; Stevens, 1977; Phillips and Devroede, 1979). The differences in diet establish the need for selective processing of the ingesta as well as a place where the excreta take the final form. There is a reasonable correspondence between the structure of various parts of the colon and the digestion of specific kinds of food substances. It is therefore no surprise that the whole structure of the colon and the proportion of its different parts vary considerably among Carnivores, Herbivores and Omnivores. However, some generalizations are possible. The macromorphological features of the colon, rectum and anal canal in most domestic animals have been dealt with textbook of veterinary anatomy (Ellenberger and Baum, 1943; Schummer and Nickel, 1979; Evans, 1993; Dyce, Sack and Wensing, 1996). In addition to some publications (Borelli, Fernandes Filho, D'errico and Pereira, 1978; Ibrahim, 1983; Wally, 1986). However, the morphometric studies on the colon and rectum were scarce. Therefore, this study aimed to give more detailed information on the quantitative measurements and the systematic description of the different parts of the large intestine concerned in the formation of the final form of the fecal matter in three species of animals representing Carnivora (Dog), Ruminantia (Goat) and Equidae (Donkey).

MATERIALS and METHODS

The present study was carried out on mature healthy animals including 15 dogs, 15 goats and 15 donkeys of both sexes and different ages. The body length of the animals under investigation was measured according to Latimer and Sawin (1959). The animals were anesthetized and then thoroughly bled to death from the common carotid artery, perfused with a solution of 10% formalin, 4% phenol and 1% glycerin and left for 3-7 days for fixation.

The topography of the colon and rectum was studied on five animals of each species fixed in normal standing position. The measurements of the large intestine as well as the description of some parts of the colon in which the fecal matter took its final forms and the rectum as a caudal continuation of the colon was confined on the rest of the animals.

These measurements include the length and the diameter of the different parts of the large intestine in addition to, the number and dimensions of the saccules and folds of the descending colon of the donkey. The data was statistically analysed by SAS (1990). The nomenclature used in this work is that adopted by the Nomina Anatomica Veterinaria (1983).

RESULTS

The large intestine is the caudal extension of the alimentary canal. The classical anatomical divisions includes the Cecum, Colon (Colon ascendens, Colon transversum and Colon descendens), Rectum and Canalis analis.

The large intestine of the dog measured about 50.60 cm ± 2.36 in length. It was 0.73 time the length of the body, whereas, the length of intestine of the goat was about 341.56 cm ± 11.7, representing 3.95 times the length of the body. In the donkey, the large intestine measured about 544.2 cm ± 7.93 and was 3.75 times the length of the body (Tab. 1). The large intestine of the donkey was more complex as it possessed muscular bands (Taeniae) and sacculations (Haustra).

Examination of the different parts of the colon and their contents in the animals under investigation revealed that, the fecal matter took its final form in the descending colon in the dog and donkey. While, in the goat, the coat took its final form earlier in the beginning of the centrifugal gyri of the Ansa spiralis of the ascending colon. Therefore, the current work was done on the before mentioned parts of the colon in addition to the centripetal gyri of the ascending colon, transverse colon and rectum from comparative points of view.

(A) Colon ascendens:

a) Ansa spiralis coli:

The spiral loop of the ascending colon of the goat (Plate I: Fig. 1,2) was arranged in coils consisting of centripetal, centrifugal gyri of two and half to three turns each and a central flexure. Only the last centrifugal gyrus showed regular constrictions. The length of the centripetal and centrifugal turns was 78.2 cm ± 3.55 & 123.9 cm ± 4.29, respectively (Tab. 1).

In the empty state, the interior of the spiral loop showed low longitudinal folds. However, in distension with fecal matter (Plate I: Fig.

1), the mucosal surface possessed ill-developed transverse folds in the centripetal turns (Plate I: Fig. 2). These folds became apparent and regularly arranged in the centrifugal ones (Plate I: Fig. 2) separating the fecal matter into pellets (Plate I: Fig. 1) and gave them a somewhat saccular appearance, especially at the last centrifugal gyrus.

b) Ansa distalis coli:

The distal loop of the ascending colon connected the spiral one with the transverse colon. It measured about 23.9 cm ± 1.12 (Tab. 1). It began with a constriction at the end of the spiral loop and nearly at the level of a flexure between the proximal and spiral ones. The mucous membrane of the distal loop showed impressions of the grouped fecal pellets and well-developed transverse folds (Plate I: Fig. 2).

(B) Colon transversum:

The transverse colon of the dog (Plate III: Fig. 1) measured about 7.37 cm ± 0.27. Its diameter was about 1.68 cm ± 0.12. In the goat, the transverse colon measured about 8.65 cm ± 0.38 and its diameter 1.43 cm ± 0.08. In the donkey, it measured about 12.4 cm ± 0.26 in length. Its diameter reached 6.5 to 7.8 at the junction with the ascending colon at the right colic flexure then decreased gradually to 4.5 to 5.0 cm as it passed to the descending colon at the left colic one (Tab. 1). The transverse colon constituted about 14.9%; 2.6% and 2.3% of the total length of the large intestine in the three studied animals, respectively (Tab. 2 & Hist. 1).

The transverse colon of the studied animals lied in front of the cranial mesenteric artery crossing the median plane from the right side to the left one, relating dorsally to the pancreas and the roof of the abdominal cavity.

The mucous membrane of the transverse colon of the dog was raised into longitudinal folds that faded out by distension with the semifluid luminal contents. However, in the goat, the mucous membrane and the fecal content of the transverse colon had the same appearance as that of the distal loop. The external surface of the transverse colon of the donkey showed two longitudinal bands or Taeniae (mesenteric and antimesenteric) in ten of the examined animals (Plate IV: Fig. 1). These bands were the direct continuation of the dorsal medial and lateral bands of the right dorsal colon. In the rest of specimens, only one band was observed as a direct continuation of the dorsal medial band of the right dorsal colon. The mucous membrane showed either complete or incomplete irregular transverse folds and contained semifluid fecal matter (Plate IV: Fig. 2).

(C) Colon descendens:

The mean length of the descending colon of the dog was about 13.10 cm ± 0.71 and the mean diameter was about 1.56 cm ± 0.10. In the goat, it measured 38.5 cm ± 1.93 in length and the diameter was about 1.37 cm ± 0.09. However, in the donkey, the mean length of the descending colon was 162.1 cm ± 3.98 and its diameter including the saccules was about 4.80 cm ± 0.06 (Tab. 1). The descending colon formed about 25.9%, 11.3% and 29.8% of the total length of the large intestine in dog, goat and donkey, respectively (Tab. 2 & Hist. 1).

The descending colon extended from the termination of the transverse colon nearly at the first lumbar vertebra in the dog (Plate III: Fig. 1,2) or at the level of the last thoracic vertebra in the donkey, to the rectum. In the latter animal, it was arranged in coils, intermingled with those of the jejunum in the left flank region (Plate IV: Fig. 3). In the goat, the descending colon was included in the intestinal disc that found on the right side of the abdominal cavity. It began on the left side, inclined to the right at the caudal border of the right kidney and then to the median plane shortly after forming the sigmoid colon (Plate II: Fig. 3) at the level of the six lumbar vertebra.

The external surface of the descending colon of the donkey was marked by two well-developed mesenteric and antimesenteric longitudinal muscular bands, Taeniae coli, as well as two rows of sacculations, Haustra, (Plate IV: Fig. 1 & Plate V: Fig. 4). The mesenteric taenia was the direct continuation of the dorsal medial band of the right dorsal colon that crossed the transverse colon. This band was attached to the mesocolon and reached about 1.2 to 1.6 cm in width, while the antimesenteric one was either the direct continuation of the dorsal lateral band of the right dorsal colon that crossed the transverse one or originated at the beginning of the descending colon. The width of this band was about 2.1 to 2.6 cm at its widest part. These bands extended along the whole length of the descending colon or terminating gradually at the last 4 Haustra in five cases.

The number of the saccules of the descending colon was37 to 56, separated from each other by deep transverse furrows projecting into its lumen, while the width between two successive folds was about 2.56 cm ± 0.06 (Tab. 1).

In the dog, the fecal matter appeared somewhat harder than that of the transverse colon and took its final form as one column without segmentation (Plate III: Fig. 2). In the empty state (Plate III: Fig. 3), the luminal surface of the descending colon demonstrated longitudinal folds

from which small lateral ones arise giving them a somewhat irregular and weavy appearance. These folds effaced by distension of the colon.

The mucous membrane of the descending and sigmoid colon in the goat was thrown into longitudinal folds of varying height and length which disappeared by distension and replaced by impressions of the grouped fecal pellets (Plate II: Fig. 1). Moreover, a constriction of 1.5 to 3.0 cm in length was observed either between the sigmoid and the descending colon or between the former and the rectum, characterized by the presence of well-developed longitudinal folds (Plate II: Fig. 1).

The mucous membrane of the descending colon of the donkey showed numerous regularly arranged semilunar or valvular folds, Plicae semilunares coli, (Plate V: Fig. 1,3,4) corresponding to the fore-mentioned transverse furrows. The mean height of these folds was about 1.62 cm $\pm$ 0.05 (Tab. 1). The facing folds might be closely opposing each other (Plate V: Fig. 2) or forming a slit-like opening inbetween, acting as a partition between the fecal matter. At the level of the taeniae, small longitudinal folds were present (Plate V: Fig. 3). The end form of the fecal matter appeared as bean-shaped dry balls arranged mostly singly in the intervals between the semilunar folds (Plate IV: Fig. 4)

(E) Rectum and Canalis analis:

The rectum and anal canal of the studied animals were the direct continuation of the descending colon in the pelvic cavity. In the dog, the mean length of the rectum and anal canal was about 13.55 cm $\pm$ 0.52. It composed of a narrow cranial part with a mean diameter of about 1.98 cm $\pm$ 0.12 and a wide caudal part (Ampulla recti) with a mean diameter of about 2.79 cm $\pm$ 0.14. In the goat, the rectum and anal canal measured about 19.31 cm $\pm$ 1.13 in length with a diameter of about 2.77 cm $\pm$ 0.09. In the donkey, they were about 31.9 cm $\pm$ 0.72 in length. While, the diameter of the rectum was 4.81 cm $\pm$ 0.22 at its cranial part and 6.61 cm $\pm$ 0.13 at its caudal part, Ampulla recti (Tab. 1). The rectum and anal canal constituted about 27%, 5.7% and 5.9% of the total length of the large intestine of the dog, goat and donkey, respectively (Tab. 2 & Hist. 1).

The rectum was related dorsolaterally to the pelvic wall, while the ventral relations depend upon the sex. In females, it was related to the cervix of the uterus and vagina in addition to the body of the uterus in goat and she-donkey. In males, the rectum was related to the ductus deferens, genital fold, uterus musculine, pelvic urethra and urinary bladder. It was also related to the prostate gland in all animals in

addition to the ampulla ductus deference, seminal gland or vesicle and bulbourethral gland only in goat and donkey.

The mucous membrane of the empty rectum of the dog presented longitudinal folds (6 in number) and short secondary ones which arise at the right angles of the longitudinal ones. These short transverse folds were either connected or intermingled with those of the opposite side giving the mucous membrane a corrugated appearance (Plate III: Fig. 4). At the beginning of the ampulla the longitudinal folds were gradually disappeared while, the short transverse ones became more apparent, larger and converted into complete irregular transverse folds intermingled with each other (Plate III: Fig. 4). When the rectum was distended with the solid fecal matter mostly the transverse folds disappeared. The rectal mucosa showed in addition numerous oval and rounded pits (Plate III: Fig.2& 4).

In the goat and donkey, the rectal mucosa demonstrated longitudinal folds. In distension, it showed impressions of either fecal pellets (Plate II: Fig. 1,2,3) or solid fecal balls which were delineated by transverse folds (Plate V: Fig. 4). In the goat, the caudal part of the rectum formed the Columnae rectales of about 2.5 to 10.0 cm in length. The presence of 7 to 9 longitudinal folds and narrow lumen that appeared always empty characterized this region (Plate II: Fig.4).

DISCUSSION

In the present study, the large intestine of the dog measured about 36.3 to 59.2 cm in length. However, it ranged from 60.0 to 75.0 cm (Raghavan and Kachroo, 1964; Ellenport, 1975), 28.0 to 90.0 cm (El-Hagri, 1967; Schummer and Nickel, 1979) or 0.2 to 0.6 meter (Strombeck and Guilford, 1991) in the same animal. The large intestine of the goat measured about 284.0 to 412.0 cm in length but El-Hagri (1967) and Schummer and Nickel (1979) found it to be about 4.0 to 8.0 meters. The length of the large intestine of the donkey was about 510.0 to 577.0 cm which is nearly equal to the measurements of Borelli et al. (1978) about 5.60 meters in the same animal. However, in the horse the large intestine is more longer and reaches about 7.5 to 8 meters as mentioned by Raghavan and Kachroo (1964) and Sisson (1975) or 6.0 to 9.0 meters as stated by Schummer and Nickel (1979) or 25.0 feet by Bone (1982).

The present investigation revealed that the large intestine of the dog was relatively shorter than that of the goat and donkey. It was 0.73,

3.95 and 3.75 times the length of the body in the animals under investigation, respectively.

In agreement with Dukes (1955) and Dyce et al. (1996) the fecal pellets of the goat, were formed at the beginning of the centrifugal gyri. However, Currie (1988) stated that the colon of sheep and goat usually contains aggregates of fecal pellets.

The present study revealed that, the length of the transverse colon of the dog ranged from 6.0 to 8.5 cm. Drazner (1985) and Burrows (1986) gave nearly similar measurements that were 5.0 to 8.0 cm. While, Evans (1993) reported that the transverse colon measured 7.0 cm. In the goat and donkey, it reached about 7.0 to 10.0 cm and 11.0 to 14.0 cm in length, respectively. The transverse colon was short in the goat and donkey when compared with that of the dog. In the latter animal, it constituted about 15% of the total length of the large intestine. While, that of the goat and donkey was nearly equal, about 2.6% and 2.3%, respectively. In the donkey, the transverse colon showed either one or two longitudinal bands (Taeniae). Burns (1992) and Dyce et al. (1996) mentioned also such findings in the horse.

The mucous membrane of the transverse colon demonstrated longitudinal folds in the dog and goat, which faded out by distension in the former animal or replaced by transverse folds separating the impressions formed by grouped fecal pellets in the latter one. However, in the donkey the mucosa of the transverse colon showed either complete or incomplete irregular transverse folds.

The descending colon of the dog ranged from 9.0 to 16.0 cm similar to that stated by Drazner (1985) who gave it as to be about 10.0 to 16.0 cm. However, in the goat its length was about 30.0 to 52.0 cm In the donkey, the length of the descending colon was about 146.0 to 182.0 cm which is nearly equal to the half length of that of the horse (3.5 meters) as reported by Sisson (1975) or (2.5 to 4 meters) by Schummer and Nickel (1979). The descending colon of the donkey was the longest of the studied animals, where it formed about 29.8% of the total length of the large intestine, whereas in the dog and goat it constituted about 25.9% and 11.3%, respectively.

Similar to that observed by El-Hagri (1967), Habel (1975) and Schummer and Nickel (1979) in the ruminant, Wally (1986) in the camel as well as Houssainy (1996) in the rabbit, the sigmoid colon was observed only in the goat and acts as the fecal reservoir (Christensen, 1985).

In the present investigation, the descending colon of the donkey presented two taeniae and two rows of sacculations as stated by Bradley and Grahame (1946), El-Hagri (1967), Sisson (1975), Schummer and Nickel (1979) and Dyce et al. (1996) in the horse. These sacculations assist in mixing the materials within the large intestine and provide the cecum and colon of horse with different motility patterns other than ruminants and carnivores (Breazile, 1971). In accordance with that described by Chauveau and Arloing (1891), Bradley and Grahame (1946) and Dyce et al. (1996) in the horse; the descending colon of the donkey formed interiorly large crescentic or semilunar folds corresponding to the external constriction.

The present study showed that the descending colon of the dog contained firm feces, while that of the goat contained groups of dry fecal pellets. Dyce et al. (1996) reported similar observations in the same animals. Dry fecal balls were observed within the descending colon of the donkey which simulate those described by Chauveau and Arloing (1891) and Dyce et al. (1996) in the horse. Moreover, Christensen (1985) stated that the motor functions of the descending colon are directed more to the concentration of feces through absorption and to the formation of solid stools. Dukes (1955), Breazile (1971) and Strombeck and Guilford (1991) stated that the function of the colon of the dog is to absorb salt and water and to serve as a reservoir for the waste materials that constitute the feces. The latter are expelled at intervals from the bowel by the act of defecation. On other hand, Starling (1926) reported that the colon absorbs also small amount of proteins of meat and fat in addition to its chief function as excretion.

In the present investigation, the length of the rectum and anal canal was relatively short in the goat and donkey when compared with those of the dog. In the latter animal, they were about 11.0 to 16.5 cm in length. On the other hand, Drazner (1985) and Evans (1993) found that the rectum measured 4.0 to 6.0 cm or 5.0 cm respectively. In the goat, the rectum and anal canal were about 15.0 to 26.0 cm While, in the ox, the rectum measured 30.0 cm (Rrghavan and Kachroo, 1964). In the camel, it was 40.0 cm (Hegazi, 1945) or 0.38 to 0.45 meter (Wally, 1986). In the donkey, the rectum and anal canal ranged from 29.0 to 35.0 cm the length. However, in the horse only the rectum is about 20.0 to 30.0 cm (El-Hagri, 1967; Sisson, 1975). The rectum and anal canal were relatively longer in the dog when compared with those of goat and donkey. In the former animal, they comprised about 27% of the total

length of the large intestine while, in the goat and donkey its percentage was nearly equal about, 5.7% and 5.9%, respectively.

In the dog, the luminal surface of the empty rectum showed longitudinal folds at its cranial part and transverse ones at the rectal ampulla. Moreover, numerous mucosal pits were observed representing the solitary lymph follicles mentioned by Evans (1993), Stinson and Calhoun (1993) and Dyce et al. (1996) in the same animal. The rectal mucosa of the goat and donkey showed longitudinal folds simulating that of the ruminant and horse (Habel, 1975; Bone, 1982, respectively). However, in the distended state, the mucous membrane of the rectum showed impressions of either fecal pellets in the goat or fecal balls in the donkey which were delineated by the transverse folds. Schummer and Nickel (1979) and Dyce et al. (1996) in the small ruminants also observed such folds. However, Wally (1986) in his study on the camel concluded that, the mucous membrane of the rectum presents transverse and longitudinal folds in addition to numerous scattered Peyer's patches.

In agreement with those described by Habel (1975) and Schummer and Nickel (1979) in ruminants, the rectal mucosa of the goat just cranial to the anal canal demonstrated longitudinal folds (Columnae rectales). On the other hand, Raghavan and Kachroo (1964) in ox described the anal columns that could not be detected in the three animals under investigation.

The present study revealed that, the rectum was generally distended with end form of the fecal matter (column in dog, pellets in goat or balls in donkey) as recorded by Schummer and Nickel (1979) & Dyce et al. (1996). These observations suggested a storage function of the rectum prior to evacuation (Alvarez, 1928; Schummer & Nickel, 1979; Frandson & Whitten, 1981; Bone, 1982; Dyce et al., 1996).

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LEGENDS

Plate I

Fig. 1 & 2: Photographs showing the topography and the interior of the spiral and distal loops of the ascending colon of the goat. Left aspect. Mesojejunum (A), Ren dexter (B), Ren sinister (C).

Jejunum (1), Ansa proximalis coli (2), Gyri centripetales (3), Flexura centralis (4), Gyri centrifugales (5).

Fecal matter (arrow), singly arranged fecal pellets (arrowhead), ill-developed Plicae transversales (double arrow), well-developed Plicae transversales (double arrowhead), impressions of the fecal pellets (asterisk).

Plate II

Fig. 1,2,3: Photographs showing the interior of the descending colon, sigmoid colon and rectum of the goat. Right aspect.

Os sacrum (A), Ren sinister (B), Vesica urinaria (C), Organa genitalia feminina (D).

Duodenum (1), Jejunum (2), Cecum (3), Ansa proximalis coli (4), Colon descendens (5), Colon sigmoideum (6), Rectum (7).

Groups of fecal pellets (arrow), Plicae transversales recti (arrowhead), impressions of the grouped fecal pellets (asterisk), constriction between Colon sigmoideum et Rectum (double arrow).

Fig. 4: Photograph showing the rectal column of the goat. Rectum (1), Columnae rectales (2), Canalis analis (3). Plicae longitudinales (arrow).

Plate III

Fig. 1 & 2: Photographs showing the topography of intestinal tract of the male dog after removal of the jejunum, ileum, most of the greater omentum and urogenital organs. Ventral aspect. Ventriculus (A), Omentum majus (B), lig. Duodenocolicum (C), A. mesenterica cranialis (D), Lien (E).
Duodenum (1), Ileum (cut, 2), Cecum (3), Colon ascendens (4), Colon transversum (5), Colon descendens (6), Rectum (7). Fecal column within the descending colon (arrow), and rectum (double arrow).

Fig. 3: Photograph showing the interior of the descending colon of the dog. Plicae longitudinales (arrow).

Fig. 4: Photograph showing the interior of the rectum of the dog. Empty state. Plicae transversales recti (arrow), pits (arrowhead).

Plate IV

Fig. 1: Photograph showing the intestinal tract of the donkey. Jejunum (1), Colon dorsale dextrum ad Colon ascendens (2), Flexura coli dextra (3), Colon transversum (4), Flexura coli sinistra (5), Colon descendens (6).
Taenia libera medialis ad Colon ascendense (a), Taenia libera lateralis ad Colon ascendense (b), Taeniae mesocolica dorsalis ad Colon transversum (c), Taeniae libera ventralis ad Colon transversum (d), Taenia libera ventralis ad Colon descendens (e).

Fig. 2: Photograph showing the interior of the transverse colon and the beginning of the descending one of the donkey. Colon transversum (1), Colon descendens (2). Plicae transversales (arrow).

Fig. 3: Photograph showing the topography of the descending colon and rectum of the donkey, after reflection of the left dorsal and ventral parts of the ascending colon and the jejunum. Left aspect.
Os sacrum (A), Longissimus lumborum (B), Ren sinister (C), Lien (D).
Jejunum (1), Cecum (2), Colon ascendens (3), Colon descendens (4), Rectum (5).

Fig. 4: Photograph showing the descending colon of the donkey after incision of some saccules.
Mesocolon (A)
Taeniae mesocolica dorsalis ad Colon descendens (1), Taenia libera ventralis ad Colon descendens (2). Haustra (arrow), fecal balls (arrowhead).

Plate V

Fig. 1: Photograph showing the interior of the descending colon of the donkey, after incision and removal of the fecal balls.
Mesojejunum (A).
Haustra (asterisk), Plicae semilunares coli (arrow), Taenia libera ventralis ad Colon descendens (arrowhead).

Fig. 2: Photograph showing a transverse section of the saccules of the descending colon of the donkey.
Plicae semilunares coli facing each other (arrows), Taenia libera ventralis ad Colon descendens (arrowhead), Mesocolon (asterisk).

Fig. 3: Photograph showing the interior of the descending colon of the donkey (The descending colon was opened dorsally and reflected).
Mesocolon (A), Plicae semilunares coli (arrow),Plicae longitudinales (arrowhead).

Fig. 4: Photograph showing the interior of the rectum and the terminal part of the descending colon of the donkey.
Colon descendens (1), Rectum (2).
Plicae semilunares coli (arrow), Plicae transversales recti (arrowhead), impressions of the fecal balls (asterisk).

Table 1: Showing the measurements of the different parts of the large intestine of the dog, goat and donkey (in cm)

Items	Dog		Goat		Donkey	
	Range	Mean ± S.E.	Range	Mean ± S.E.	Range	Mean ± S.E.
TL-Intestinum crassum	36.3-59.2	50.60±2.36	284-412	341.56±11.7	510-577	544.2±7.93
L. Cecum	5.8-18.0	13.20±1.22	17-25	21.60±0.85	75-120	89.80±4.67
L. Colon ascendens	2.5-5.0	3.38±0.24	215-309	253.5±9.04	221-260	248±3.54
L. Ansa proximalis coli			23-41	29.5±2.21		
L. Ansa spiralis coli			174-242	200.1±6.55		
L. Gyri centripetales			65-96	78.2±3.55		
L. Gyri centrifugales			104-152	123.9±4.29		
L. Ansa distalis coli			18-30	23.9±1.12		
L. Colon transversum	6.0-8.5	7.37±0.27	7-10	8.65±0.38	11-14	12.4±0.26
L. Colon descendens	9.0-16.0	13.10±0.71	30-52	38.5±1.93	148-182	162.1±3.98
N. Haustra coli					37-56	54.4±2.72
M.D. Haustra coli					4.52-5.1	4.80±0.06
MW. Haustra coli					2.26-2.90	2.56±0.06
MH. Plicae semilunares coli					1.29-1.90	1.62±0.05
L. Rectum & Canalis analis	11.0-16.5	13.55±0.52	15-26	19.31±1.13	29-35	31.90±0.72
D. Colon ascendens	1.0-1.8	1.46±0.06	-	-	-	-
D. Ansa proximalis coli			3.0-3.5	3.36±0.12	-	-
D. Gyri centripetales			1.1-1.5	1.28±0.04	-	-
D. Gyri centrifugales			1.0-1.5	1.17±0.06	-	-
D. Ansa distalis coli			1.2-1.5	1.36±0.05	-	-
D. Colon transversum	1.0-2.2	1.68±0.12	1.0-1.2	1.43±0.08	4.5-5.0	4.72±0.06
D. Colon descendens	1.0-2.0	1.56±0.10	1.0-2.0	1.37±0.09	4.52-5.1	4.80±0.06
D. Rectum	1.0-2.3	1.98±0.12	2.5-3.3	2.77±0.09	4.0-6.0	4.81±0.22
D. Ampulla recti	2.3-3.6	2.79±0.14	-	-	6.0-7.3	6.61±0.13
Body length	63-75	68.50	75-97	86.40	133-152	144.9
Ratio of the length of the large intestine to the body length	0.58-0.80	0.73	3.78-5.17	3.93	3.61-3.90	3.75

TL. Total length **L.** Length **D.** Diameter /**N.** Number
MD. Mean diameter **MW.** Mean width **MH.** Mean height

Table 2: Showing the length percentage of the different parts of the large intestine to its total length in the dog, goat and donkey.

Items	Dog		Goat		Donkey	
	Range	Mean	Range	Mean	Range	Mean
Cecum	15.978-30.702	25.55	5.986-6.676	6.32	14.706-21.016	16.46
Colon ascendens	5.291-8.446	6.68	71.739-75.775	74.21	43.257-48.170	45.61
Colon transversum	11.494-22.039	14.87	1.923-3.257	2.55	2.072-2.426	2.28
Colon descendens	21.959-29.703	25.91	9.014-14.286	11.27	27.916-32.941	29.78
Rectum & Canalis analis	24.164-30.303	26.98	4.451-6.311	5.65	5.254-6.667	5.87

Histogram 1: Showing the length percentage of the different parts of the large intestine to its total length in dog, goat and donkey. Cecum (C), Colon ascendens (Ca), Colon transversum (Ct), Colon descendens (Cd), Rectum & Canalis analis (R&Can).

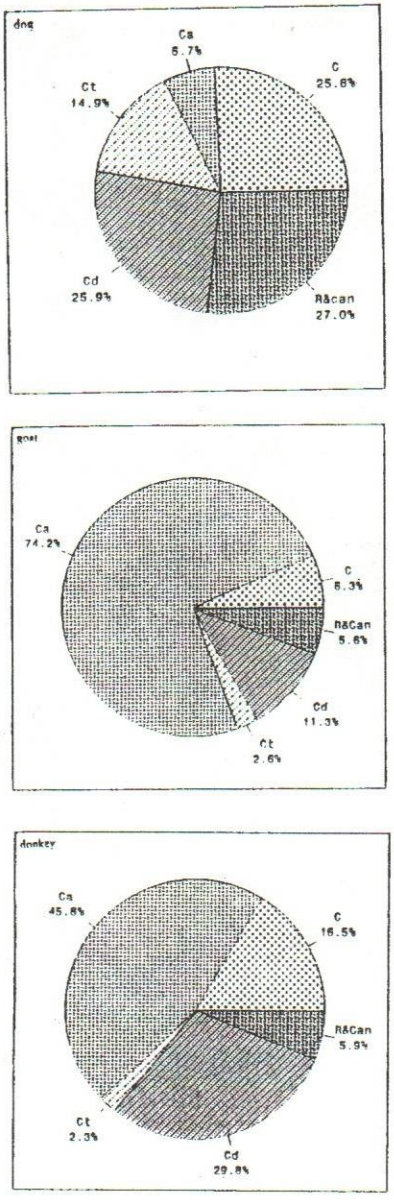
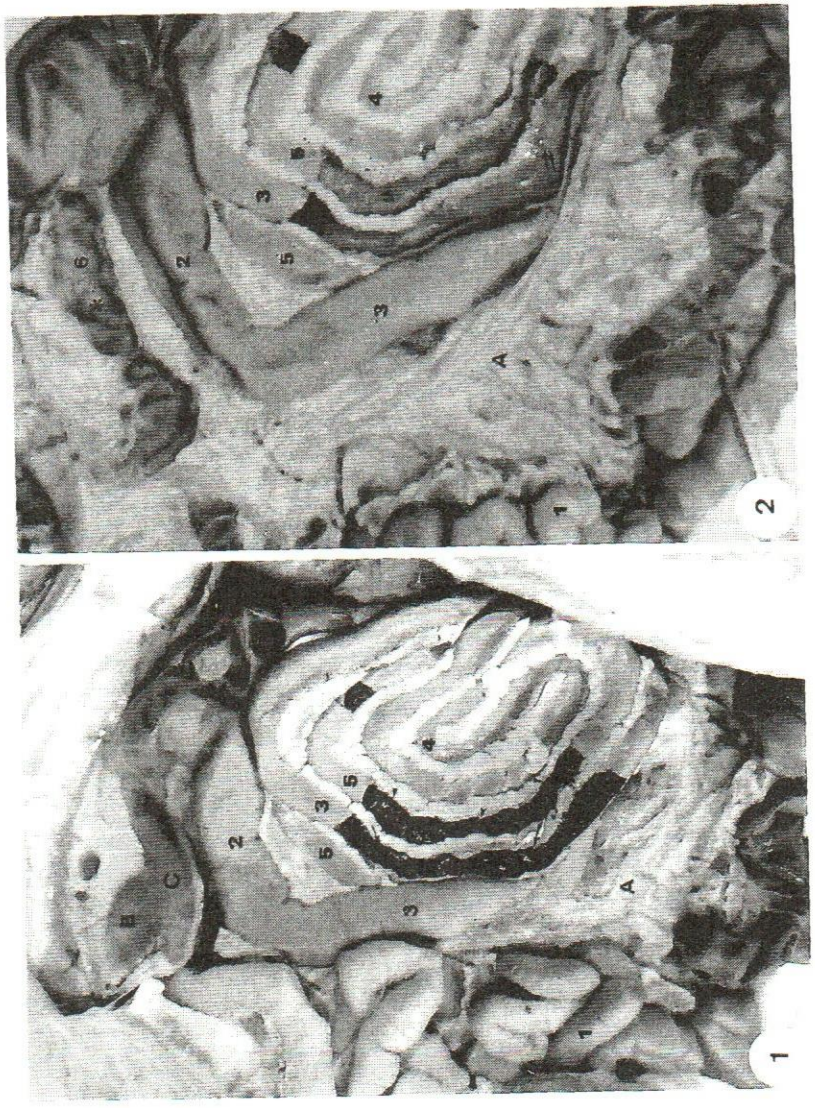


Plate I



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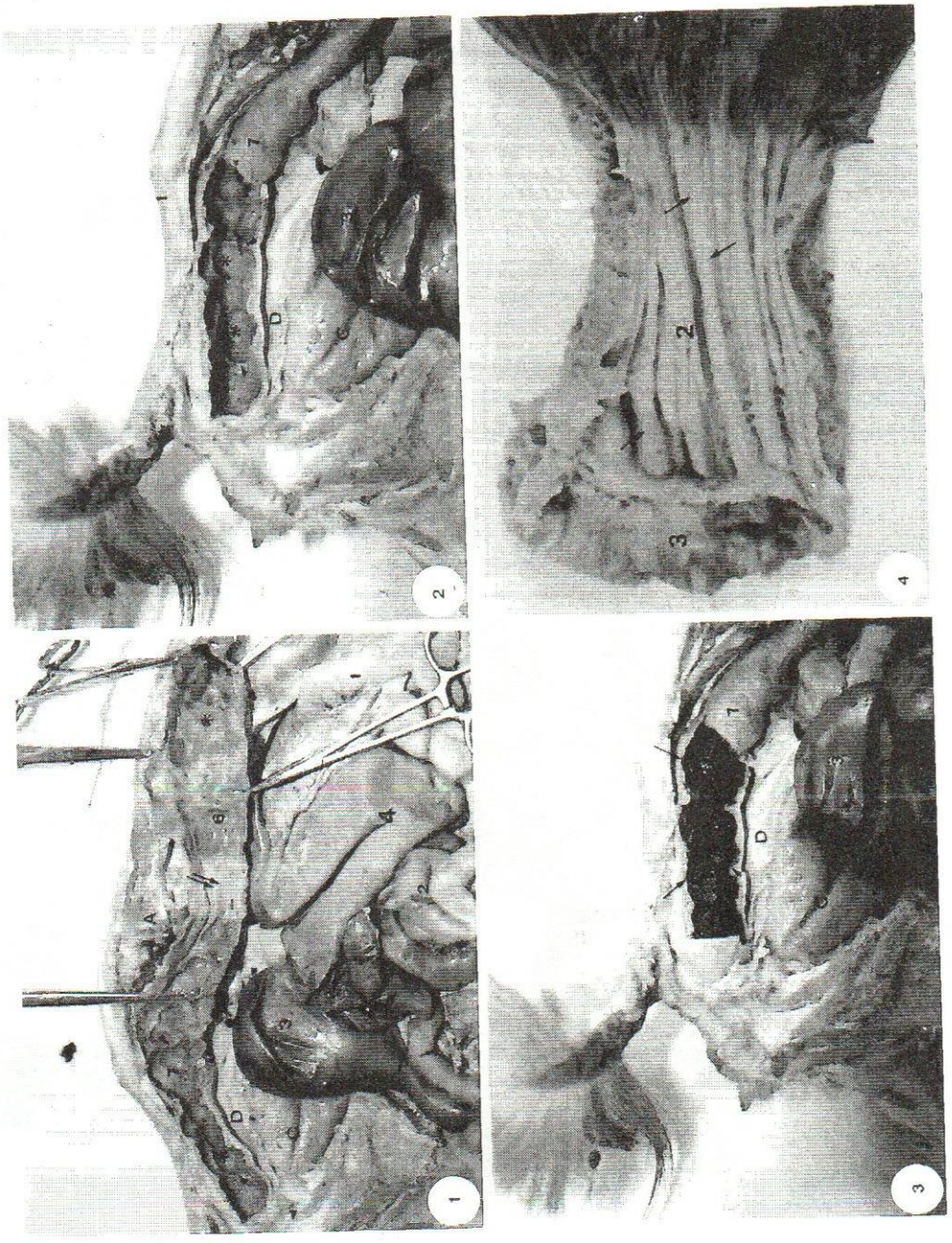

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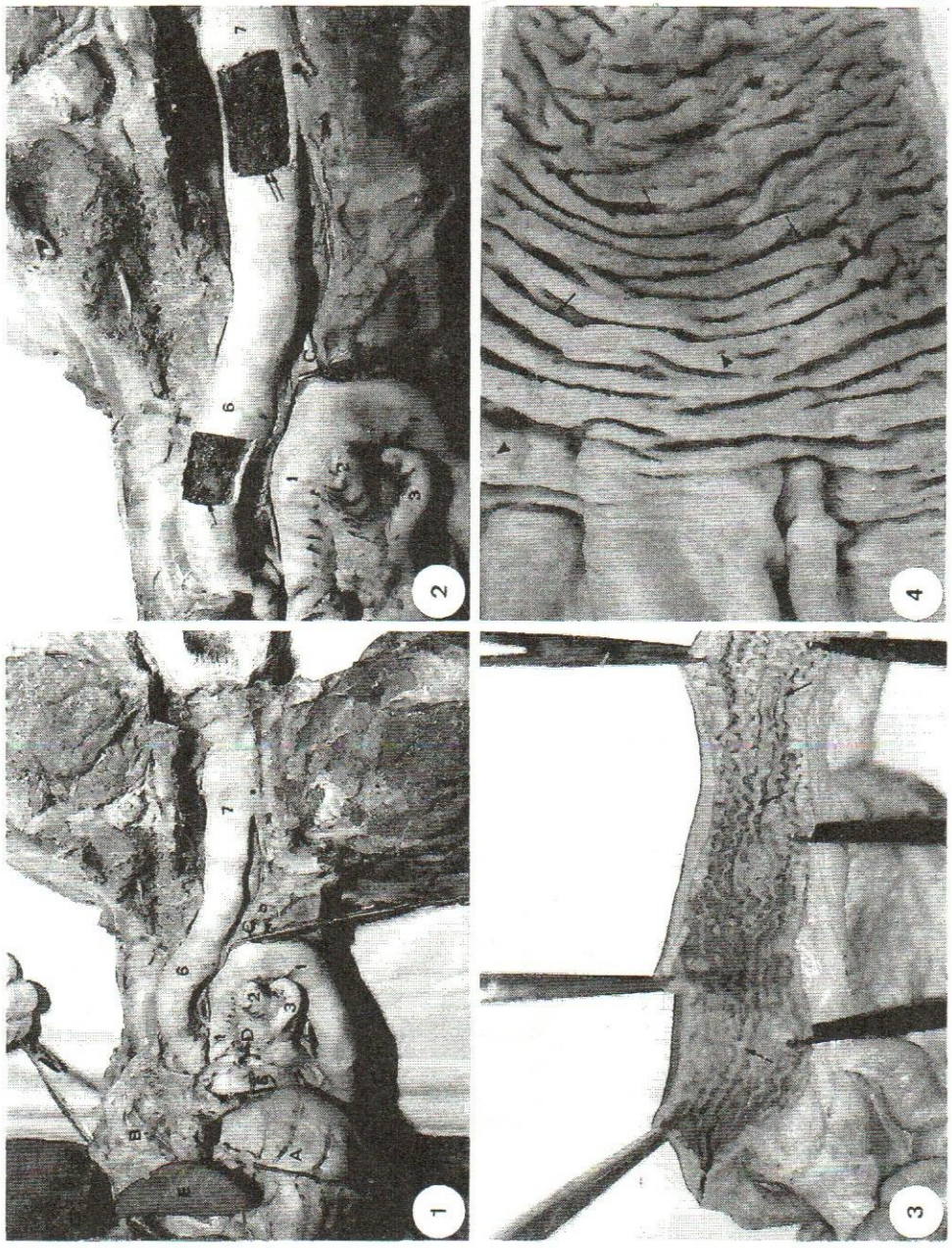

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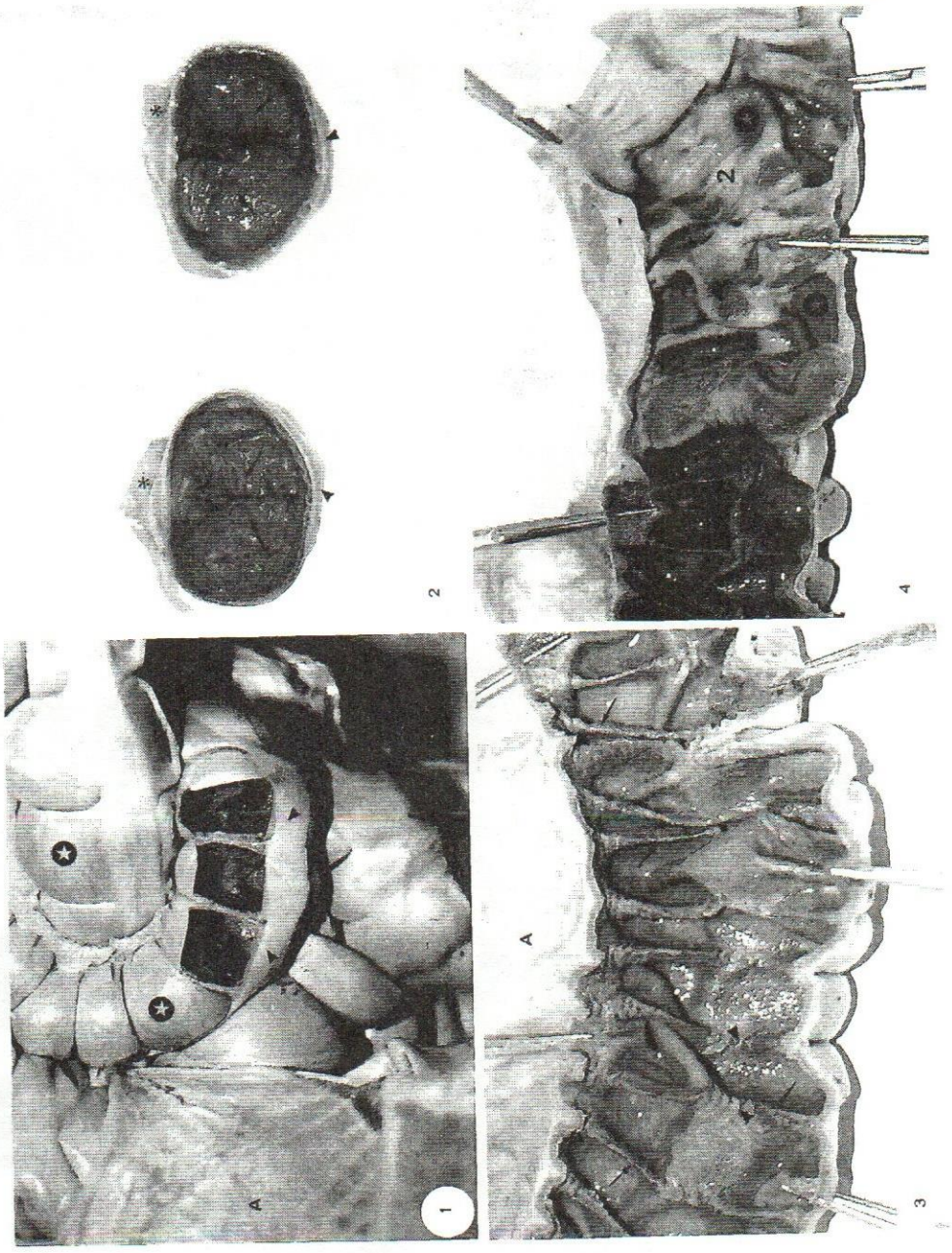

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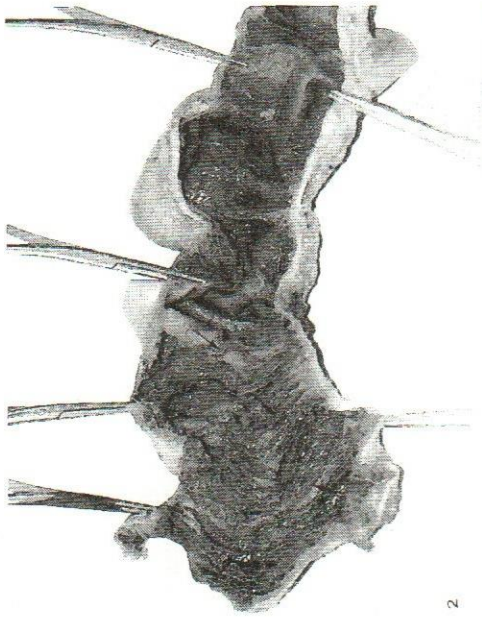

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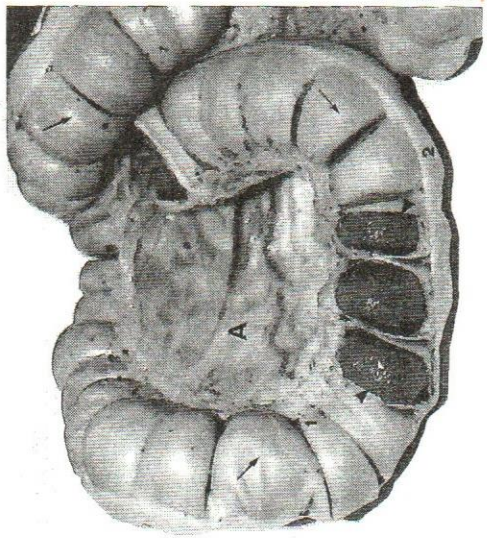

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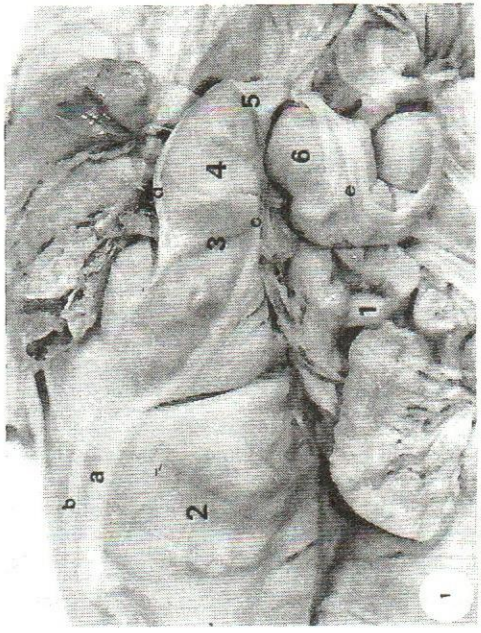

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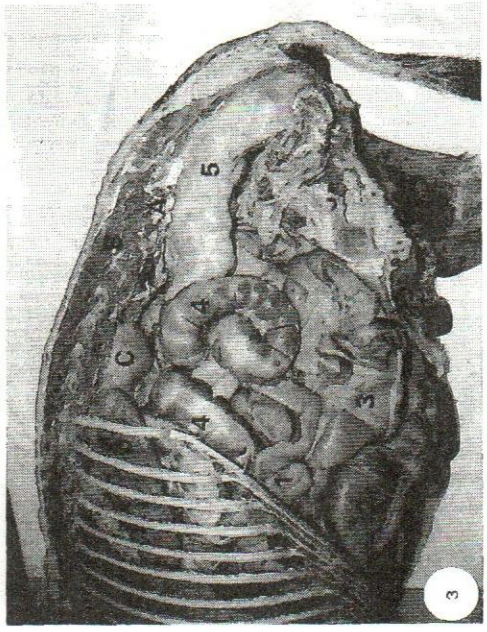

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