Original article

Microvascularization of the colon and rectum of the dog by scanning electron microscopy

Bernardes, A.[1]*, Coelho, P.[1], Carreira, C.[2], Teixeira, L.[1], O'Neill, JG.[3]

[1]Institute of Human Normal Anatomy, Faculty of Medicine, University of Coimbra, Experimental Investigation Laboratory, Coimbra University Hospital(Portugal), Rua Larga, 3004-504, Coimbra, Portugal
[2]Institute of Human Normal Anatomy, Faculty of Medicine, University of Coimbra and National Institute of Legal Medicine, Central Branch, Largo da Sé Nova, 3000-213, Coimbra, Portugal
[3]Institute of Human Normal Anatomy, Faculty of Medical Sciences, University of Lisbon, Rua Campo dos Mártires, 130, 1169-056, Lisboa, Portugal
E-mail: bernardesbernardes@gmail.pt

Abstract

The aim of the present work was to study the normal microscopic arterial morphology of the descending colon and rectum in the dog. For this study, we used the organs of five dogs (*Canis familiaris*), which were injected with Mercox® through the caudal mesenteric artery, and studied by scanning electron microscopy. The branches of the long and short straight arteries and the anastomoses that join them, form four intraparietal plexuses which progressively, from the outwards inwards, were designated as: subserosal, muscular, submucosal and mucosal. The subserosal plexus is formed by an irregular rectangular shaped network, with its greater diameter being transversal. The muscular plexus is situated between the submucosal and subserosal plexuses. The plexus of the external muscular layer emits interfascicular longitudinal arterioles that form numerous anastomoses with one another, from which, in turn, the fascicular arterioles emerge. The internal muscular plexus emits interfascicular transverse arterioles, perpendicular to the greatest axis of the colon, forming numerous anastomoses with one another, from which the fascicular arterioles emerge.The submucosal plexus is situated between the internal muscular and mucosal plexuses. The centrifugal arterioles emerge from these to the muscular layers as well as the centripetal arterioles, the deep submucosal or mucosal arterioles, which are directed to the mucosa, forming the corresponding plexus. The mucosal plexus is formed by pre-capillary arterioles, situated at the base of the mucosa near the muscular mucosa, by interglandular capillaries throughout its thickness and by periorificial or periglandular capillaries. Each intraparietal plexus of the colon has an abundant vascular architecture with numerous anastomoses. It may be concluded that the irrigation of the organ, from an anatomical point of view, is of the anastomotic type.

Keywords: microvascularization, colon and rectum, scanning electronic microscopy.

1 Introduction

In a previous paper, Bernardes (1996), we described in great detail the long straight arteries (long str. a.) and short straight arteries (short str. a.) of the descending colon and rectum of the dog, classifying their collateral and terminal branches. In order to make the present paper more comprehensive, we summarize and present the results schematically in Figure 1.

We observed that the long str. a. emits two types of collaterals: mesocolic and colic or parietal branches.

The mesocolic collaterals are also of two types, transversal and oblique. Furthermore, the oblique branches may be direct or recurrent and, additionally, the direct oblique branches may be subdivided into visceral or mesocolic. The oblique direct visceral branches may be of three types: short str. a., subserosal branches and external muscular branches, depending on which layers they end in, being respectively the submucosal, subserosal or external muscular layers.

The colic or parietal branches emerge from the long str. a. or from one of their terminal divisional branches as they cross the corresponding layers of the colon. They are of five types: external muscular, external interfascicular, internal muscular, recurrent muscular and submucosal branches.

From the short str. a.two types of collateral branches emerge: the mesocolic and colic or parietal branches. The mesocolic are all oblique direct visceral branches, subserosal or external muscular branches, whilst the colic or parietal branches may be of various types: external muscular, external interfascicular, internal muscular, recurrent muscular and submucosal. The short str. a. end by dichotomic division once they have reached the submucosa, giving rise to ventral and dorsal branches. These vessels join the submucosal branches, collaterals of the long str. a..

The aim of this paper was to study the normal microscopic arterial vascularisation of the descending colon and rectum of the dog and to classify their arterioles and capillaries.

2 Materials and Methods

Five dogs were used, 3 females and 2 males, weighing between 10.8 to 18.1 kg, 13.7 ± 3.6 kg on average with the upper and lower limits varying between 12.7 and 14.6 kg ($p < 0.05$).

The animals were anesthetized with kethamine hydrochloride and sacrificed with an intracardiac potassium

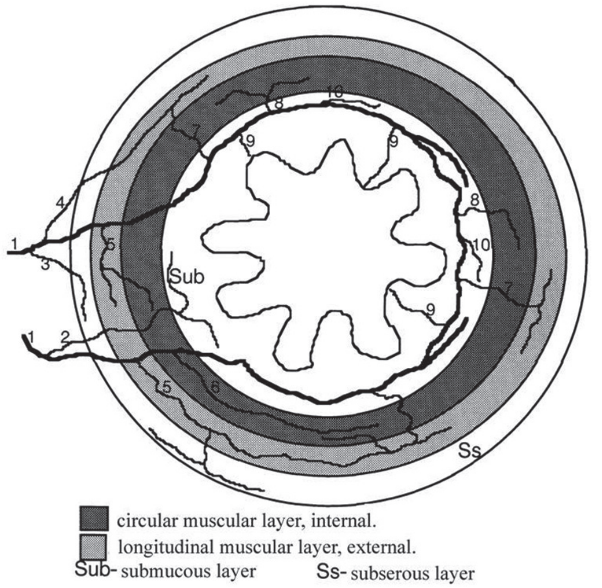

Figure 1. Long (1.) and short straight arteries (2.) and their collaterals; (3.) subserosal oblique mesocolic branch; (4.) external muscular oblique mesocolic branch; (5.) external muscular parietal branch (p.); (6.) internal muscular p. branch; (7.) long recurrent muscular p. branch; (8.) short recurrent muscular p. branch; (9.) deep submucosal p. branch; (10.) tangent oblique submucosal p. Branch.

chloride injection. In all cases, an infra-umbilical medial celiotomy was performed, with the identification and mobilization of the descending colon and caudal mesenteric artery. A canola was then introduced into the caudal mesenteric artery and the vascular bed was perfused with a heparinized saline solution at 37 °C. The marginal artery was subsequently ligated along the proximal third of the ascending colon. According to O'Neill (1983) and Lametschwandtner, Lametschwandtner and Weiger (1984), glutaraldehyde at 2.2% with a phosphate buffer to fix the constituents of the cellular endothelium allows a better view of their highlights. The vascular beds were also perfused with Mercox® in a continuous mode and at constant pressure inside the cadaver, after the disappearance of peristaltic movements, as recommended by Konerding (1991) and Murakami (1971, 1978).

The organs remained at normal room temperature for 12 hours, in a dry container, in order to obtain complete polymerization. The pieces were then corroded and cleaned using sodium hydroxide and water as detergent. The casts were maintained in alcohol at 70 °C, rendering them less consistent, which facilitates the organs dissection without breaking any important parts.

Several fragments from the different casts were collected after dehydration in a hot oven at 50 °C and were mounted on a metal stand. The fragments were sputtered with a thin layer of gold salts (30 nm thickness) according to other authors (GANNON, 1978; MURAKAMI,1978; O'NEILL, 1983;AHARINEJAD, GANGLER, HAGEN et al., 1992; SKINNER and O'BRIEN, 1996; ARAKI, FURUYA, KOBAYASHI et al., 1996; CHRISTOFFERSON and NILSSON, 1988), and the pieces were then observed and photographed under anISI-SX-30 scanning electron microscope. Measurements of microvessel diameters were takenusing an automatic micron scale, as described by other authors (MURAKAMI, 1978; O'NEILL, 1983; SKINNER and O'BRIEN, 1996).

This technique proved to be essential for the study of vessels with a calibre smaller than 20 μm, especially in the capillaries of the mucosa.

3 Results

The collateral and terminal branches of the longand short str. a. and the anastomosis between them form an intraparietal vascular network, making up true plexuses that irrigate the various layers of the colon. Next, we describe the four plexuses present in the colon of the dog (Figures 2, 3, 4 and 5).

The subserosal plexus, situated between the serosal and external muscular layers of the colon, is the most superficial one andit is easily visible through the serosa. The afferent vessels of this plexus are subserosal arterioles that derive from the mesocolic branches of the long str.a. the mesocolic branches of the short str.a. and from the external muscular collateral branches of the long str.a. and short str.a.. The majority of the subserosal arterioles are recurrent branches of the external muscular arterioles.

The subserosal arterioles of the mesocolic border of the intestine are all of the direct type, according to the classification proposed by Bernardes (1996), and emerge from mesocolic branches that,in turn, arise from the long and short str.a. during their course through the mesocolon.

In the subserosal space, the subserosal arterioles establish anastomoses amongst themselves, constituting an irregular network without a true geometric arrangement, although they often form a rectangular shape, with its greater diameter being transversal.

The muscular plexus is situated between the submucosal and subserosal plexuses. Generally it is composed by direct vessels of the external muscular arterioles (branches of the long and short str.a.) and by the recurrent branches that arise from the submucosal plexus. In the dog colon we did not observe the so called 'intermuscularplexus' that exists in human beings, Bernardes (1996). We shall describe the vessels of the external and internal muscular layers separately.

The external muscular plexus'afferent vessels are different, depending on the part of the intestine on consideration:

a) the arterioles of the justamesocolic quadrants of the colon or of the dorsal surfaces of the rectum, have the following afferent branches: external oblique muscular mesocolic branches (collaterals of the long or of the short str.a.), parietal external muscular branches, external interfascicular branches and long recurrent muscular branches (intraparietal collateral branches of the long and short str.a.);
b) the arterioles of the external muscular plexus of the antimesocolic quadrants of the colon or of the ventral surface of the rectum, have as afferents the long recurrent muscular branches of the terminal branches of the long str.a..

The external muscular and long recurrent muscular branches emit as collateral branches, the interfascicular arterioles.These course longitudinally between the smooth

Figure 2. S.E.M. Intraparietal plexuses of the colon of the dog - superficial serosa of the intestine: (1) straight vessels; (2) arterioles of the subserosal plexus (35x).

Figure 4. S.E.M. Intraparietal plexuses of the colon of the dog: (1) capillaries of the subserosal plexus; (2) external muscular capillaries (150x).

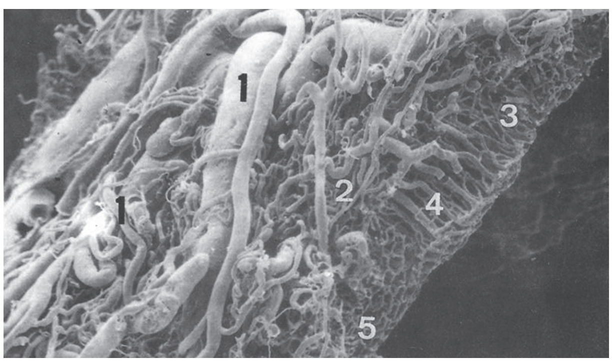

Figure 3. Transverse section of the colon: (1) serosal surface; (2) submucosa; (3) mucosal surface; (4) interglandular capillaries; (5) periglandular capillaries (35x).

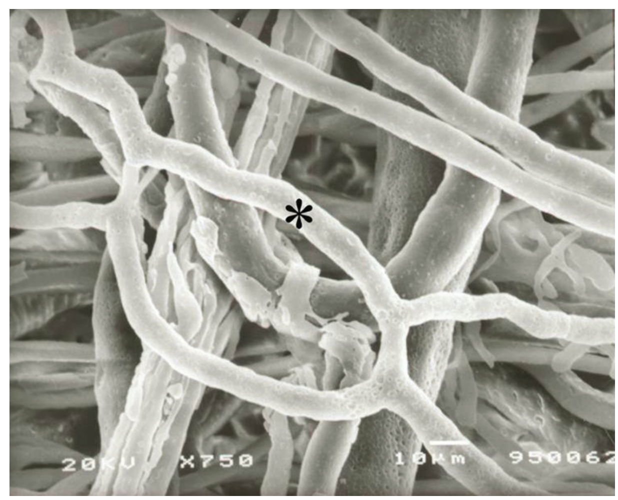

Figure 5. Longitudinal anastomoses between 4 capillaries (*) of the subserosal plexus (750x).

muscular fibres of the external muscular layer, with an almost straight course, and establish three types of anastomoses: longitudinal or of the 1st order, transversal or of the 2nd order and oblique, similar to the transversal anastomosis. The calibre of the interfascicular arterioles varies between 10 and 30 µm, 21.3 ± 8.14 µm on average, ranging from 19.9 to 22.7 µm ($p < 0.05$). These arterioles and their successive anastomoses, longitudinal and transversal, form a large rectangular network with its greatest axis being longitudinal, from which emerge the fascicular arterioles that course transversely inside the muscular fibres. Their width varies between 10 and 15 µm, 12.6 ± 2.57 µm on average, with upper and lower limits being 11.9 and 13.2 µm ($p < 0.05$).

The internal muscular plexus' afferent arterioles are also different, depending on the part of the intestine in question:

a) the arterioles of the justamesocolic quadrants of the colon, or of the dorsal surface of the rectum, have the following afferent branches: external muscular mesocolic branches (collaterals of the long and short str.a.), internal parietal muscular and recurrent muscular branches (intraparietal collaterals of the long and short str.a.) and internal muscular branches (which emerge from the external muscular plexus);

b) the arterioles of the internal muscular plexus of the other quadrants of the colon and rectum have the recurrent muscular branches, already described as afferents.

The afferents of the internal muscular plexus, throughout the thickness of its homonymous layer, end in a dichotomic division, giving rise to the interfascicular arterioles. They course transversally to the greatest axis of the viscera and are thus, parallel to the circular fibres of the layer in question. The interfascicular arterioles course between the muscular fibres and establish two types of anastomoses: 1- transversal or of 1st order, "circular" between the interfascicular arterioles that emerge from the adjacent muscular arterioles; 2- longitudinal or of 2nd order, between collateral interfascicular arterioles of the same vessel, perpendicular to the internal muscular fibres. The width of the interfascicular arterioles varies between 10 and 20 µm, 16.1 ± 4.25 µm on average, with upper and lower limits varying between 15.1 and 17.1 µm ($p < 0.05$). These arterioles and their successive anastomoses, longitudinal and transversal, form a large rectangular network, with its greatest axis being transversal, from which emerge the fascicular arterioles. Their width varies between 10 and 15 μm, 12.3 ± 2.55 μm on average, with upper and lower limits varying between 11.7 and 12.9 μm ($p < 0,05$).

The fascicular arterioles emit capillaries that establish transversal, longitudinal and oblique anastomoses, also forming a large rectangular network, with its greatest axis being parallel to the course of the muscular fibres. Thus, the greatest diameter of the network in the external muscular layer is longitudinal, whilst that of the internal muscular layer is transversal. The width of these capillaries varies between 6 and 10 μm, 7.8 ± 1.47 μm on average, with upper and lower limits varying between 7.4 and 8.2 μm ($p < 0.05$).

The submucosal plexus is situated between the mucosal and internal muscular layers and receives terminal branches from the long and short str.a.. It emits numerous arterioles to the muscular plexus and provides all the blood supply to the mucosal plexus. The plexus' afferent vessels are submucosal collateral branches from the long and short str.a.. The terminal branches of the long str. a. in the submucosa, along the free border of the colon, join the long str. a. of the opposite side of the colon, forming transverse anastomoses, in a manner in whichthey almost seem to close the circle initiated by the long str. a. along in the mesocolic border, Bernardes (1996). We shall describe the submucosal plexus along the colonic and rectal surfaces and borders separately:

a) Along the descending colons ventral and dorsal surfaces or along the left and right lateral sides of the rectum, the long str.a. or its terminal branches emit the submucosal arterioles. These course tangentially, in cranial or caudal direction, forming longitudinal anastomoses (parallel to the viscera's greatest axis) between adjacent long str.a. branches. These primary anastomoses have a calibre that varies between 40 and 80 μm, 61.9 ± 15.01 μm on average, with upper and lower limits varying between 58.3 and 65.5 μm ($p < 0.05$). In between the primary anastomoses there are secondary ones, organized transversely. They measure between 20 and 40 μm in width, 33.7 ± 8.38 μm on average, with upper and lower limits varying between 31.7 and 35.7 μm ($p < 0.05$). The former anastomoses form an irregular polygonal network, with its greater axis being longitudinal oblique;
b) Along the free border of the colon and ventral side of the rectum, there are anastomoses of the 1st order, transversal between the terminal branches of the long str.a. of opposite sides, or between a terminal branch of one side and a submucosal collateral of the other. Their calibre varies from 40 to 90 μm, 56.2 ± 19.68 μm on average, with upper and lower limits varying between 51.5 and 60.9 μm ($p < 0.05$). Along the course of these vessels, collaterals emerge at right angles, longitudinally, at irregular intervals, ascending and descending, to form 2nd order anastomoses, parallel to the greatest axis of the organ. Their calibre varies between 20 and 50 μm, 34.4 ± 11.21 μm on average, with upper and lower limits between 31.7 and 37.1 ($p < 0.05$). The network formed by these anastomoses is more irregular and has no definite geometric shape associated with it;
c) Along the mesocolic border of the colon and dorsal side of the rectum, a submucosal plexus is formed by the union of the submucosal branches from the long and short str.a., forming 1st order anastomoses, in a transversal layout, with a calibre measuring 40 to 80 μm, 60.2 ± 13.31 μm on average, with upper and lower limits varying between 57.0 and 63.4 μm ($p < 0.05$). Between these transversal anastomoses, there are 2nd order longitudinal ones, with a calibre that varies between 20 and 40 μm, 31.2 ± 4.63 μm on average, with upper and lower limits varying between 30.1 and 32.3 μm ($p < 0.05$). The network formed by these anastomoses is also very irregular, with no true geometric shape associated with it.

From these anastomoses, centrifugal arterioles emerge to the muscular layers as well as centripetal branches, deep submucosal or mucosal arterioles to vascularise the base of the mucosa (Figures 6 and 7).

The mucosal plexus is formed by vessels at the base of the mucosa and capillaries throughout its thickness. The deep submucosal and mucosal branches (collateral branches of the straight arteries or from their terminal branches) at the mucosal base, emit collateral and terminal branches with a calibre that varies between 10 and 30 μm, 19.4 ± 8.26 μm on average, with upper and lower limits varying between 17.4 and 21.4 μm ($p < 0.05$). These arterioles cross the muscular mucosa and give rise to pre-capillary arterioles, with a calibre that varies from 9 to 14 μm, 10.6 ± 3.12 μm on average, with upper and lower limits between 9.7 and 11.2 μm

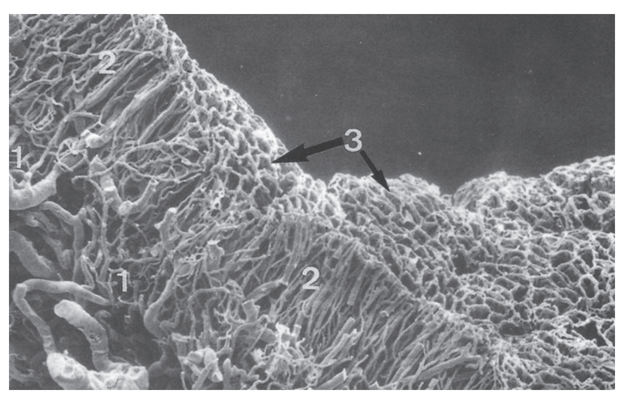

Figure 6. (1) vessels of the submucosa; (2) interglandular capillaries; (3) periglandular capillaries (50x).

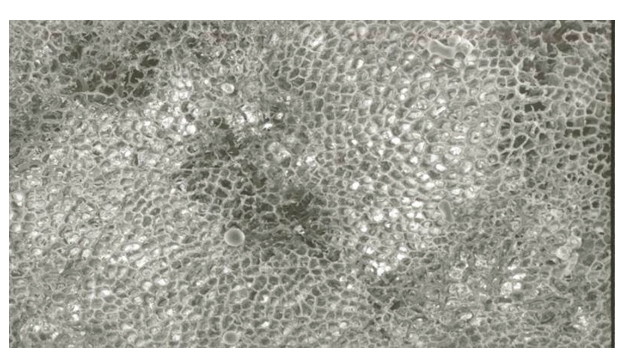

Figure 7. Plexus of the mucosa of the descending colon of dog with numerous rings of periglandular capillaries (35x).

($p < 0.05$). The pre-capillary arterioles, in turn, give rise to interglandular or cryptic capillaries, which penetrate the base of the crypts (or interglandular spaces) and course along the entire thickness of the mucosa, perpendicular to its surface in an irregular manner. Once they reach the subepithelial vertice in the interglandular space, they end in trifurcation or,as in 86% and 14% of our cases, in four periorificial or periglandular capillaries (Figures 7 and 8).

In the descending colon the interglandular capillaries have a calibre that varies between 5 and 10 µm, 7.8 ± 1.34 µm on average, with upper and lower limits varying between 7.5 and 8.1 µm ($p < 0.05$). Their length varies between 150 and 400 µm, 263.3 ± 87.06 µm on average, with upper and lower limits varying between 242.4 and 284.2 µm ($p < 0.05$). Each mucosal gland is accompanied along its greatest axis, from the base to its vertice by 4 to 6 capillaries, 4.1 ± 0.93 µm on average, with upper and lower limits varying between 3,9 and 4,3 ($p < 0,05$).

In the subepithelial space there is a network of vessels, the periorificial or periglandular capillaries, that form numerous rings at the crypts vertices and around the glands openings. The rings have diameters that vary between 40 and 80 µm, 56.8 ± 12.32 µm on average, with upper and lower limits varying between 53.8 and 59.8 µm ($p < 0.05$). The calibre of these periorificial or periglandular capillaries varies from 4 to 10 µm, 6.8 ± 1.43 µm on average, with upper and lower limits varying between 6.5 and 7.1 µm ($p < 0.05$). These capillary rings are generally quite simple. They may, however, be duplicated or unfolded at different points, usually near one or more vertices of the adjacent crypts. This distribution of various rings in the mucosa has been compared to a honeycomb.

In the rectum, the mucosal plexus has a similar organization as described in the descending colon, although the interglandular capillaries have a length that varies between 150 and 250 µm, 189.8 ± 39.65 µm on average, with upper and lower limits varying between 180.3 and 199.3 µm ($p < 0.05$). Their width varies between 7 and 10 µm, 8.2 ± 1.52 µm on average, with upper and lower limits varying between 7.8 and 8.6 µm ($p < 0.05$). Along its length, the interglandular capillaries accompany the same gland and are joined by numerous superimposed rings, from the base up to the subepithelial surface, in an almost uninterrupted manner. The periorificial or periglandular capillaries, on the other hand, are frequently double or triplicate in several segments around the opening of the same gland. The rings have diameters that vary from 40 to 100 µm, 58.2 ± 11.41 µm on average, with upper and lower limits varying between 55.5 and 60.9 µm ($p < 0.05$). The width of these periorificial or periglandular capillaries varies between 4 and 10 µm, 6.4 ± 1.32 µm on average, with upper and lower limits that varies between 6.1 and 6.7 µm ($p < 0.05$) - Figures 9 and 10.

4 Discussion

The corrosion of vascular casts is a relatively old technique. To obtain these casts, the investigators tested various products, but encountered the same two fundamental problems concerning viscosity and retraction. To carry out macroscopic studies, the acrylic resins used (ESPERANÇA PINA, 1972; NERANTZIS, ANTONAKIS and AVGOUSTAKIS, 1978) minimized these limitations, especially regarding the retraction issue. The manufacture of synthetic resins,such as Mercox® or Batson number 17®, which are less viscous, has allowed studies by means of scanning electron microscopy (S.E.M.) of vascular casts. These products have the following important characteristics (GANNON, 1978): 1- the capacity to fill small vessels; 2- an insignificant retraction fraction (6%); 3- good mechanical stability of the cast during corrosion of the

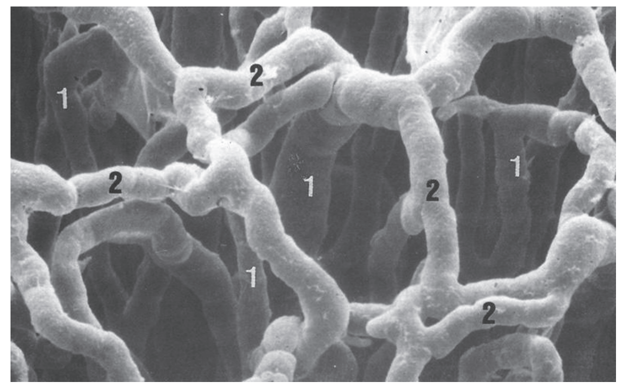

Figure 8. Rings of periglandular capillaries (50x).

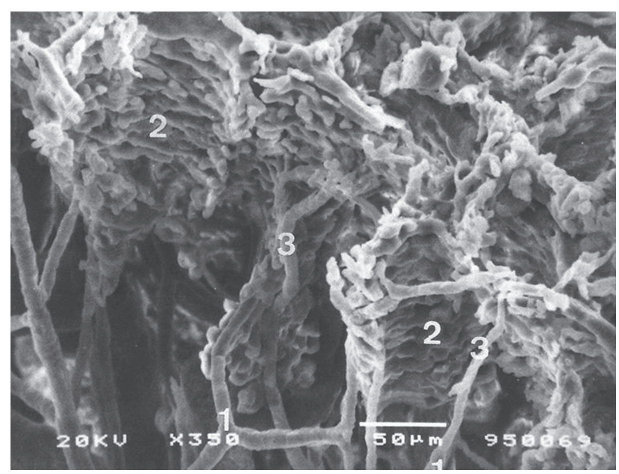

Figure 9. S. E. M. Plexus of the mucosa of the rectum of the dog: (1) pre-capillary arterioles; overlapping rings of the horizontal capillaries that join the interglandular capillaries (350x).

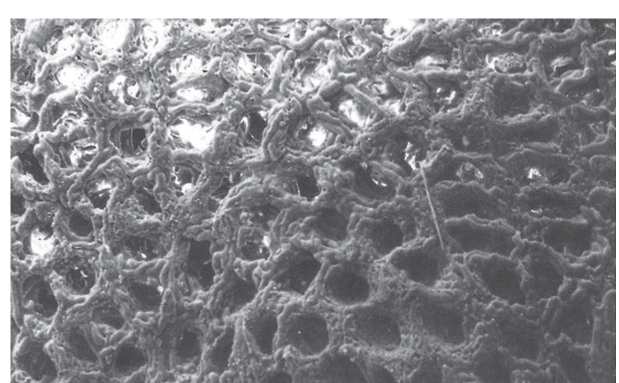

Figure 10. Numerous rings of periglandular capillaries (50x).

tissues; 4- resistance to metalization and 'bombing' by the electrons of the microscope.

Weiger, Lametschwandtner and Stockmayer (1986) and Konerding (1991) claim, however, that this does not constitute the ideal solution. Many authors (AHARINEJAD, LAMETSCHWANDTNER, FRANZ et al., 1991; AHARINEJAD, GANGLER, HAGEN et al., 1992; ARAKI, FURUYA, KOBAYASHI et al., 1996, BERNARDES, 1996; ESPERANÇA PINA, 1972; LAMETSCHWANDTNER, LAMETSCHWANDTNER and WEIGER, 1984; MURAKAMI, 1971; MURAKAMI, 1978; NERANTZIS, ANTONAKIS and AVGOUSTAKIS, 1978; O'NEILL, 1983; SUN, ZHANG, WU et al., 1992; ZAHNER and WILLE, 1996), nevertheless, highlight the advantages of this technique since it allows excellent filling and visualization of all microvessels; it's the best method to observe the angio-architecture in three dimensions owing to its great focusing and resolution capacity; it has the ability to perform morphometric studies, namely the evaluation of the calibre of the vessels and intercapillary distances; it performs microdissection; it distinguishes arteries and veins, according to the endothelial impressions of their nuclei, elongated and parallel to the greatest axis of the vessel in the arteries, whilst oval or round, less prominent and with no fixed orientation in the veins (SKINNER and O'BRIEN, 1996). On the other hand, Ohtani, Kikuta, Ohtsuka et al. (1983) recognised that this technique has limitations too, such as the loss of the proper vascular structure and the relations with the vessels and other tissue elements.

In the colon of the dog, the anastomoses between the branches of the long and short str. a. form four plexuses that, from the surface to a deeper plane are designated: subserosal, muscular, submucosal and mucosal. The subserosal plexus main afferents are the recurrent subserosal arterioles, collaterals of the external muscular branches of the long and short str.a.. This plexus also receives subserosal arterioles from the mesocolic branches (from the long and short str.a.), which are the principal afferents of the mesocolic border plexus. The subserosal networks in the dog are formed by irregular nets, forming a rectangular organization with their greatest axis being transversal.

The muscular plexus receives numerous branches of varying width, emphasizing the functional importance of this plexus. Aharinejad, Lametschwandtner, Franz et al (1991) describes that the *colonic tunica muscularis* of the rat is supplied by submucosal vessels only. In the dog however, there are direct afferents from the external muscular arterioles and recurrent arterioles from the submucosal plexus.

Unlike in human beings (BERNARDES, 1996), in the dog we did not find the so called 'intermuscular plexus'. The external muscular plexus has a greater number of afferents near the mesocolic border than at the free border of the colon. At the justamesocolic and dorsal quadrants of the rectum, the plexus afferents are the direct branches and the long recurrent muscular branches. The afferents of the plexus, situated in the antimesocolic and dorsal quadrants, are almost all recurrent. The external muscular branches emit longitudinal interfascicular arterioles, with a significantly superior calibre than their corresponding ones in human beings (BERNARDES, 1996). They form amongst themselves numerous anastomoses, from which the fascicular arterioles emerge.

The internal muscular plexus of the justamesocolic and dorsal quadrants of the rectum, receives direct branches and vessels from the external muscular plexus, as well as recurrent branches. The afferents of the internal plexus, situated in the antimesocolic and ventral quadrants of the rectum are, as in the external one, all recurrent, deriving from the submucosa. The internal muscular branches emit transversal interfascicular arterioles, perpendicular to the greatest axis of the colon, with a significantly inferior calibre than their corresponding external ones. They too form numerous anastomoses among themselves but are of two types only: longitudinal and transversal, from which the fascicular arterioles emerge with a similar calibre to their corresponding external partners.

The submucosal plexus is situated between the internal muscular and mucosal plexuses and has as afferents the submucosal branches from the long and short str.a.. They are perpendicular to the viscera's greatest axis.This contrasts with the findings in the rats submucosal vessels, which are predominantly arranged in a parallel manner to the colons longitudinal axis (AHARINEJAD, GANGLER, HAGEN et al., 1992).

Along the ventral and dorsal surfaces of descending colon, or along the left and right sides of the rectum, submucosal arterioles of adjacent long str.a. join each other to form primary or 1st order anastomoses, which are longitudinal and parallel to the greatest axis of the organ. Between them, we find 2nd order anastomoses, with a calibre that is significantly inferior and perpendicular to the 1storder anastomoses. Along the colons free border and the rectums anterior surface,1st order anastomosis are formed, and they are transversal to the greatest axis of the intestine. Between these, there are 2nd order anastomoses, longitudinal and perpendicular to the 1st order anastomoses, with a calibre that is significantly inferior to the primary anastomoses. Along the mesocolic border, the 1st order anastomoses are transversal and result of the union of the submucosal branches of the long str.a. with the submucosal branches from short str.a.. Between the transversal vessels there are longitudinal,2nd order anastomoses, with a calibre significantly inferior to the primary anastomoses.

From these numerous anastomoses, centrifugal arterioles emerge to the muscular layers as well as centripetal ones, deep submucosal and mucosal arterioles, which vascularise the mucosal plexus.

The mucosal plexus of the dog, as in the human colon (AHARINEJAD, GANGLER, HAGEN et al., 1992; BERNARDES, 1996; ARAKI, FURUYA, KOBAYASHI et al., 1996), is formed by pre-capillary arterioles situated at the base of the mucosa near the muscular mucosa, and by capillaries throughout its width. Interglandular capillaries are significantly longer in the descending colon than in the rectum. The calibre of these interglandular capillaries in the rectum is on average greater in the colon, although not statistically significant. These capillaries form numerous anastomoses with their similar counterparts along their course, forming rings that surround the gland, and are thus, parallel to the surface of the mucosa. Periorificial or periglandular capillaries have a similar calibre to those of the descending colon and rectum. They too, form polygonal or circular rings around the openings of the glands, which also have a similar diameter to those in the descending colon and rectum. On the whole, the capillaries of the mucosa mimic a honeycomb pattern, as Aharinejad, Gangler, Hagen et al. (1992) describes in rats and guinea pigs and Araki, Furuya, Kobayashi et al. (1996) describes in the human colon.

Even though to different extents, each of the four intraparietal plexuses of the descending colon and rectum of the dog has a rich vascular architecture. Furthermore, they all have one fact in common, that is the existence of numerous anastomoses. We can thus affirm that the irrigation or vascularization of the organ, from an anatomical point of view, is of the anastomotic type.

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