قسم التشريح والهستولوجيا
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التكون التشكلي للأوعية الدموية الجلدية في الكلاب

حلمي بدوي ، محمد رشاد ، أحمدحسن ، نبيل كامل

أجريت هذه الدراسة على ٢٦ جنينا تتراوح أطوالها من ٢٠ الى ٢٦٠ ملليمترا ، جمعت من اناث في مراحل مختلفة من الحمل ٠ ثبتت الأجنة التي تتراوح أطوالها من ٢٠ الى ٦٠ ملليمترا في محلول ١٠٪ فورمالين ، أما الأجنة التي تتراوح أطوالها من ٧٠ الى ٢٦٠ ملليمتر حقنت بمحلول الحبر الشيني والمصل بنسبة ١ : ١ في شريان أو وريد الحبل السري أو كليهما معا أو في الشريان الأبهر وبعد ذلك ثبتت في محلول ١٠٪ فورمالين ، ثم أخذت عينات من جلد هذه الأجنة من مناطق الجبهة ، الرقبة ، الابط ، الصدر ، الظهر ، البطن ، الخاصرة والفخذ ، ثم عوملت بالكحول ثم محلول البنزين ثم محلول بنزوات الميثيل والبنزين ٠

أظهرت النتائج بداية تكوين شبكة الشريان المغذية للأدمة في مناطق الصدر والبطن والسطح الوحشي للفخذ والظهر في الأجنة التي بلغ طولها ١٣٠ ملليمترا ٠ أما الشبكة الشريانية تحت الحلمية فقد أمكن تمييزها في مناطق البطن والسطح الوحشي للفخذ والظهر لنفس الأجنة ٠

لوحظ أن الشبكة الوريدية الغائرة للأدمة تحيط بوحدات المناطق الوعائية الدموية للجلد عند منطقة الظهر والبطن والصدر والسطح الوحشي للفخذ والجبهه في الأجنة التي بلغ طولها ١٣٠ ملليمترا ٠ كما ظهرت الشبكة الوريدية الغائرة تحت الحلمة في منطقة الصدر والسطح الوحشي للفخذ والجبهه والشبكة الدموية المغذية لغمد الشعر على هيئة شبكية تحيط بالجزء الداخلي لكل غمد ٠

بدأت الشبكة الوريدية تحت الحلمية الغائرة تنتظم لتقسم وحدات المناطق الوعائية الدموية في منطقة الظهر والصدر والبطن والسطح الوحشي للفخذ الى وحدات أخرى صغيرة في الأجنة التي بلغ طولها ١٣٠ ملليمترا ٠

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MORPHOGENESIS OF THE CUTANEOUS VASCULATURE IN DOGS

(With 13 Figures)

By
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SUMMARY

The cutaneous vascular pattern in dog foetuses (Egyptian land race), ranging from 20 to 260 mm CVR length, was investigated. In foetuses of 20 to 60 mm CVR length, the blood vessels appeared in the form of irregular islets of primitive blood cellular elements. In foetuses of 70 to 80 mm CVR length, the Ramus arteriosum cutaneus pierced the dermis at various sites and branched successively. It was accompanied by the Ramus venosus cutaneus in a complete satellite pattern. In foetuses of 130 mm CVR length, the primary elements of Rete arteriosum dermidis could be demonstrated at the thorax, belly, lateral surface of the thigh and back regions. The plexus venosus dermidis profundus surrounded Unit Vascular Zones at the back, belly, thorax, lateral surface of the thigh and forehead regions. The Plexus venosus subpapillaris profundus could be demonstrated at the thorax, lateral surface of the thigh and the forehead regions. The Rete capillare vaginae dermalis radicularis could be demonstrated as a simple retiform envelope around the inner portion of each hair follicle. At the forehead region, the Ramus arteriosum cutaneus was not accompanied with the Ramus venosus cutaneus. In foetuses of 170 to 190 mm CVR length, the Plexus venosus subpapillaris profundus is oriented into a retiform manner at the thorax, back, belly and lateral surface of the thigh dividing the Unit Vascular Zone into several Subunit Vascular Zones. The Rete capillare papillae pili was recognized. In foetuses of 200 - 260 mm CVR length, the Rete arteriosum subpapillare became well differentiated and distributed centrally into the Subunit Vascular Zones at all the regions examined. Few valves could be demonstrated within the vessels of the Plexus venosus dermidis profundus at the belly and flank regions.

INTRODUCTION

The qualitative and quantitative characteristics of the cutaneous vascular network is influenced by several factors. Among these are the intrinsic structural qualities of the skin and its broad local differentiation. The varying contours of the dermal-epidermal line, the different consistency of the tissue levels and the presence or absence of appendages, provide peculiar regional capillary design (MORETTI, 1968). Consequently, data concerning the cutaneous vascular architecture in several species of adult domestic animals [STIRLING (1875), HUGHES & DRANSFIELD (1959) in dogs; HAM (1944), MORITZ & HENRIQUES (1947), FOWLER & CALHOUN (1964),INGRAM & WEAVER (1969) and FORBES (1969) in pigs; RYDER

(1955 a,b) and PRISELKOVA and ZORNIA (1957) in sheep] was subjected to contradiction and controversy. Distinctions between the various networks at the different cutaneous levels in adult dogs were difficult to be ascertained from the available literature, moreover, a coordinated organization in acceptable terminology for the blood vessels in the skin was missed. In addition, the morphogenesis of the vascularization in the foetal mammalian skin was also fragmentary. These were the principal motivations for the present investigation which includes the study of the developmental changes occuring in the cutaneous hematic vessels in dog foetuses.

MATERIAL and METHODS

The material included in this investigation consisted of the skin of 26 dog foetuses obtained from bitches (Egyptian land race) sacrificed at various periods of gestation. The foetuses were recovered shortly after evisceration, weighed to the nearest gram, and the crown-to-rump (CVR) length was measured to the nearest milimeter. The entire foetuses of 20, 30, 50 and 60 mm CVR length were fixed in 10% formlin. Serial vertical paraffin sections were cut at about 7 um thickness and were stained with Haematoxylin and Eosin. The foetuses ranging from 70 - 260 mm CVR length, were injected with a 1 : 1 mixture of Indian ink and bovine serum (FATH EL-BAB, SCHWARZ, GODYNICKI, 1983). The injection routes were through the umbilical artery; the umbilical vein; both the umbilical artery and vein, or the thoracic aorta after ligature of its cardial end.

The injected foetuses were fixed in 10% formalin, then specimens were removed from the forehead, neck, axilla, thorax, back, belly, flank and thigh regions, dehydrated, cleared in benzol and followed by a 1 : 1 mixture of methylbenzoate and benzylbenzoate. The description of the blood vessels given in this study coincides with the physiological flow of blood, and the nomenclature used is that given in the Nomina Emberyologica Veterinaria, Budapest (1986).

RESULTS

The cutaneous vascular pattern in foetuses of 20 to 30 mm CVR length, appeared in the form of irregular islets of numerous primitive blood cellular elements (Fig. 1), and were surrounded with primitive endothelium represented by some mesenchymal cells (Endothelioblast).

In foetuses of 50 to 60 mm CVR length, the primordia of the cutaneous blood vessels were represented by several irregular, wide thin-walled blood vessels. They were relatively more numerous at the belly region. They occupied a relatively deeper position than the lymph vessels within the dermis (Fig. 2). The blood capillaries coursed towards the epidermis where they decreased relatively in diameter.

In foetuses of 70 to 80 mm CVR length the Rami arteriosi cutanei found access through the dermis at various sites where they were accompanied by Rami venosi cutanei. Each Ramus arterisum cutaneus divided successively into smaller branches which pursued a straight penicillar coarse towards the epidermis. The terminal branches broke down into retiform capillary bed at the juxta-epidermal region. The branches of the Ramus arteriosum cutaneus were accompanied with the branches of Ramus venosus cutaneus in a complete satellite pattern (Fig. 3 a , b). Another system of capillaries could be also demonstrated in between the areas of distribution of the previously mentioned vessels. The capillaries of this system were relatively thinner and lack satellites (Fig. 3 a). They had fewer branches which ramified beneath the epidermis where they connected with the terminal capillaries of Ramus venosus cutaneus. At the belly region, the branches of Ramus venosus cataneus followed a longitudinal

course alongside the median plane (Fig. 4).

In foetuses of 130 mm CVR length, the Ramus arteriosum cutaneus was demonstrated in most of the regions of the animal body, penetrating the dermis obliquely where it was accompanied with the Ramus venosus cutaneus, except at the forehead region, where it was accompanied bilaterally with a tiny capillary. The Rami arteriosi cutanei, at the thorax, belly, the lateral surface of the thigh and occasionally the back regions communicated with each other at the deep surface of the dermis forming the primary elements of the Rete arteriosum dermidis. The latter vessels pursued a spiral course around the Plexus venosus dermidis profundus at the aforementioned regions. The Rete arteriosum dermidis could not yet be demonstrated in the forehead region. The primorida of the Rete arteriosum subpapillare could be only demonstrated at the belly and the lateral surface of the thigh regions as small arterial vessels which converged from Rete arterisoum dermidis to nourish the Unit Vascular Zones. Some of these small arterial branches were accompanied with the primary elements of Plexus venosus subpapillaris profundus.

The Plexus venosus dermidis profundus followed a peculiar tortuous course. It surrounded relatively well defined Unit Vascular Zones, at the lateral surface of the thigh and forehead regions (Fig. 5). At the latter region, the Unit Vascular Zones were relatively narrow. The Plexus venosus dermidis profundus at the belly region was relatively thick and still aligned in a longitudinal manner at the median plane. The primary elements of the Plexus venosus subpapillaris profundus could be demonstrated at the thorax, the lateral surface of the thigh and the forehead regions as several small venous tributaries which drained the Unit Vascular Zones and joined the Plexus venosus dermidis profundus (Fig. 5). The elements of the Rete capillare vaginae dermalis radicularis could be demonstrated in all the beforementioned regions as a simple retiform jacket-like envelope around the inner portion of each hair follicle (Fig. 6). The subepidermal capillary network was well recognized in all the examined specimens (Fig. 7) (Ansa capillaris intrapapillaris).

At the 155 mm CVR length foetuses, the Rete arteriosum dermidis could be recognized as a retiform structure at the medial surface of the thigh and the forehead regions (Fig. 8). It carried on a spiral course around the Plexus venosus dermidis profundus at the lateral surface of the thigh and back regions. This rete became relatively well recognized at the flank region. The primordia of the Rete arteriosum subpapillare could be demonstrated in all regions of the body except at the thorax. At the latter region, the venous drainage could be differentiated into two systems: the first system was represented by Ramus venosus cutaneus demonstrated at the other regions, while the second system was represented by individual veins which ramified between the areas of distribution of the previous vessels. The Plexus venosus dermidis profundus kept up its tortuous course and surrounded definite Unit Vascular Zones at most (not at the neck and axilla) body regions. The Plexus venosus subpapillaris profundus could be differentiated at the medial surface of the thigh, back and flank regions as several tributaries which drained the Unit Vascular Zones. At the thorax, the latter plexus was arranged into a retiform manner, dividing the Unit Vascular Zones into some Subunit Vascular Zones (Fig. 9).

At 170, 180 and 190 mm CVR lengthes, the Rete arteriosum dermidis was predominated as spirally arranged vessels around the Plexus venosus dermidis profundus at the back, thorax, belly, lateral and medial surfaces of the thigh and axilla. The latter rete was differentiated into a retiform arrangement at 180 mm CVR length in both the flank and back regions (Fig. 10), and at 190 mm CVR length in the thorax. The plexus venosus dermidis profundus surrounded definite Unit Vascular Zones at all the regions of the body in foetuses of more than 190 mm CVR length. In addition, the Plexus venosus subpapillaris profundus is oriented into a retiform manner, dividing the Unit Vascular Zones into several Subunit Vascular Zones

at the thorax, back, belly, and thr lateral surface of the thigh (Fig. 11 a , b). The Rete arteriosum subpapillare was represented by several arterial branches which coursed outwards to nourish the Subunit Vascular Zones centrally (Fig. 12 a, b). The Rete capillare vaginae dermidis radicularis received its blood supply from the Rete arteriosum dermidis and Rete arteriosum subpapillare and was drained by Plexus venosus dermidis profundus. The Rete capillare papillae pili was recognized as a single capillary, which originated from Rete arteriosum dermidis, piercing each hair papilla.

At 200 - 260 mm CVR length, the Rete arteriosum subpapillare became well differentiated and distributed centrally into the Subunit Vascular Zones in most of the regions examined. These subunits were surrounded with the vessels of Plexus Venosus subpapillaris profundus (Fig. 13). At the axilla the vascular architecture within the dermis demonstrated a peculiar serpentine course and a complete satellite pattern. The cutaneus vascular architecture at this region was relatively ill-developed comparing to that in the other regions of the body. Few valves could be demonstrated, within the vessels of Plexus venosus dermidis profundus at the belly and flank regions (Fig. 11 a , b).

DISCUSSION

The present investigation revealed that the vascular pattern within the skin of 20 to 60 mm CVR length foetuses simulated that described in 26 days old Blackface sheep foetuses (FATH EL-BAB, ALI and SCHWARZ, 1984) and in 50 to 80 mm CR length pig feotuses (AHMED, FATH EL-BAB, SCHWARZ and GODYNICKI, 1984). The presence of these blood islets seemed to agree with the description of cutaneous hematopoiesis by POPOFF & POPOFF (1958) and FOWLER and CALHOUN (1964).

The pattern of vacularization of the skin of 70 - 80 mm CVR length differs from that described by AHMED, FATH EL-BAB, SCHWARZ and GODYNICKI (1984) in pig foetuses of 100 mm CVR length and by FATH EL-BAB, ALI and SCHWARZ (1984) in 52 days old sheep foetuses. The present study showed that the cutaneous vasculature was aligned into two vascular systems: the first system was represented by several satellite- patterned capillaries, while the second system was represented by fine capillaries ramifying in between the area of distribution of the previously mentioned vessels.

As revealed in dog foetuses of 130 mm CVR length, the organization of the cutaneous hematic vessels followed a satellite pattern except at the forehead. This verifies the opinion that the qualitative features of the skin is suscepted to significant regional variation (MORETTI, 1968). The present investigation showed that the Rami arteriosi cutanei were accompanied bilaterally in the forehead with a tiny capillary. These capillaries were termed venae comites by GOODAL and YANG (1954) and were postulated to play an important role in the conservation of the body heat. This phenomenon is achieved by an interchange of heat between the artery and its accompanying vein.

In dog foetuses of 130 mm CVR length, the Unit Vascular Zones formed a basic pattern throughout the different regions of the body These Unit Vascular Zones were previously described in bovine foetuses older than 3 months age (FATH EL-BAB et al., 1983), in swine foetuses longer than 150 mm (AHMED et al., 1984) and in sheep foetuses older than 78 days age (FATH EL-BAB et al. 1984).

The vascular zones were centrally supplied with one or more Ramus arteriosum cutaneus resembling that pattern described in sheep foetuses by FATH EL-BAB et al. (1984). This organization may substantially influence the appearance and sequence of development of the lesions in several cutaneous diseases. In addition, it may also enlighten interpretation

of the different probabilities of healing processes in the skin.

The pattern of both the Rete capillare vaginae dermalis radicularis and the Rete capillare papillae pili appeared to support the view that carbohydrates are essential for mitosis. It is therefore possible that the glycogen of the outer root sheath is transformed into glucose and carried to the papillae in support of mitosis there (BULLOUGH, 1952).

The present investigation revealed that each of the two functional fractions of the perifollicular vascular network developed rather independently; the permanent part developed from Rete arteriosum dermidis, whereas the transient part developed from Rete arteriosum subpapillare.

It has been suggested that the primary function of the cutaneous circulation is not only the maintenance of the metabolic requirements of the parenchymal structures (i.e. private vessel function) (WINKELMAN, 1961), but also it may facilitate part of the thermal and pressure regulation of the blood [i.e. public vessel function] (BURTON,1959; LEWIS & WHEELER, 1967; MORETTI, 1968, MONTAGNA and PARAKKAL, 1974). The satellite pattern as well as the presence of valves within the deeply situated plexuses, namely Plexus venosus dermidis profundus supposed its function to regulate the body temperature. However, the well developed subepidermal capillary network influences the blood pressure to a considerable extent. The vascular network distributed at the middermal level to the skin appendages may fulfil almost a nutritive activity. The Plexus venosus subpapillaris superficialis which present in cattle (FATH EL-BAB et al., 1983) and in pig (AHMED et al., 1984) could not be met with in the preparations of the present study.

The density of cutaneous vascular networks in dog foetuses differs considerably within the different regions of the body. The Unit and Subunit Vascular Zones, at the forehead of dog foetuses, were narrower than those at the other regions of the body. This arrangement provides a relative rich vascularity to this vital region, a mean which may aid heat dissipation to ensure the optimum temperature for the brain. Unlike what was observed in bovines (FATH EL-BAB et al., 1983), in dog foetuses, a sort of connection between the branches of Ramus arteriosum cutaneus and the vessels of Plexus venosus dermidis profundus and Plexus venosus subpapillaris profundus could not be domonstrated. This may enlighten interpretation of different probabilities of healing processes occuring in the skin.

The present investigation revealed that the cutaneous blood vessels at the axilla attained a peculiar serpentine course, which accomodate with the frequent motility of the skin at this region. In addition, the ill-developed cutaneous vascularization at the axilla of dog in comparison with the other regions of the body, supports the phenomenon that the cutaneous vascular beds are determined by the kinds of the skin they perfused (WINKELMAN, 1961).

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LEGEND OF FIGURES

Abraviations Used In Legends

Arteries:

1- Ramus arteriosum cutaneus.
2- Rete arteriosum dermidis.
3- Rete arteriosum subpapillare.
4- Ansa capillaris intrapapillaris.

5- Rete capillare vaginae dermalis radicularis.
6- Rete capillare papillae pili.

Veins:

7- Ramus venosus cutaneus.
8- Plexus venosus dermidis profundus. (Unit Vascular Zone).
9- Plexus venosus subpapillaris profundus. (Subunit Vascular Zone).

Fig. (1): Skin of dog foetus (20 mm CVR Length), showing an islet of several primitive blood cellular elements within the dermis. (Haematoxylin and Eosin stain, X 250).

Fig. (2): Skin of dog foetus (50 mm CVR length), showing the blood vessels (B) occupying a deeper position than the Lymph vessels (L). (Haematoxylin and Eosin stain, X 63).

Fig. (3 a): Horizontal view of the skin of dog foetus (70 mm CVR length), shoing several capillaries (C) ramifying between the areas of distribution of the satellite-patterned of 1 and 7 (AV). (X 6).

Fig. (3 b): Horizontal view of dog foetus skin (70 mm CVR length), showing the satellite pattern between 1 (A) and 2 (V). (X 36).

Fig. (4): Horizontal view of the skin of dog feotus (70 mm CVR length), showing the branches of 1 at the median plane of the belly region (arrow). (X 170).

Fig. (5): Horizontal view of the skin of dog foetus (130 mm CVR length) at the lateral surface of the thigh region, showing unit vascular zones (dotted). RR= Ramus arteriosus cutaneus and Ramus venosus cutaneus. (X 120).

Fig. (6): Vertical thick paraffin section in the skin of 130 mm CVR length foetus at the belly region, showing the primary elements of 5 (arrows). (X 63).

Fig. (7): Horizontal view of the skin of dog foetus (155 mm CVR length) at the belly region, showing a well developed subepidermal capillary network around the teat (T). (X 500).

Fig. (8): Horizontal view of the skin of dog foetus (155 mm CVR length), at the forehead region, showing 2 (A) distributed centrally into the Unit Vascular Zones (dotted), which are surrounded peripherally by the branches of 8 (V). R= Ramus arteriosum cutaneus. (X 120).

Fig. (9): Horizontal view of the skin of dog foeus (115 mm CVR length), showing Subunit Vascular Zones (dotted) at the thorax surrounded by the vessels of 9 (V). (X140).

Fig. (10): Horizontal view of the skin of dog foetus (180 mm CVR length) at the flank region, showing 2 (D) and 3 (S). Note: only the arteries are injected. (X 120).

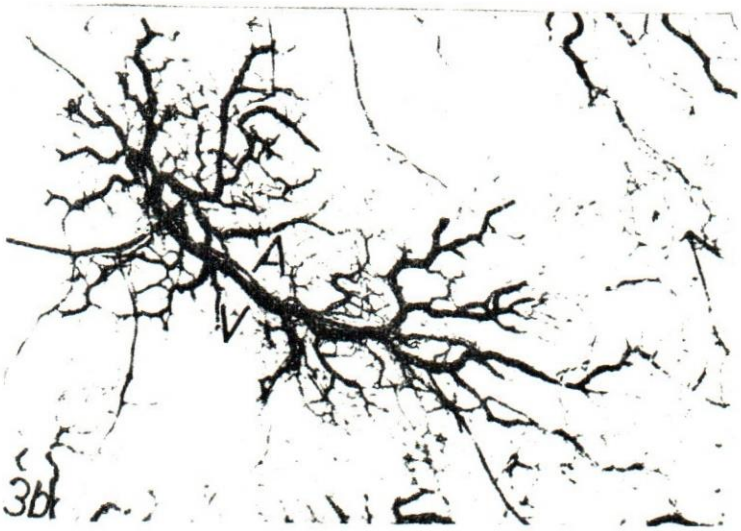
Fig. (11 a, b): Horizontal view of the skin of dog foetus (200 mm CVR length) at the belly region, showing Unit Vascular Zone (a) subdivided into Subunit Vascular Zones(b). pp= 8, ps= 9, R= 2, RR= 1 & 7. Arrow = Valve
(a, b = X 120).

Fig. (12, a,b): Horizontal view of the skin of dog foetus (200 mm CVR length) at the belly region, showing, two Subunit Vascular Zones beside each other (dotted).
p= 8, V= 9, R= 2, Arrow = Valve. (a= X120) (b= X240)

Fig. (13): Horizontal view of the skin of dog foetus (220 mm CVR length) at the forehead region, showing the central distribution of (S) within the Subunit Vascular Zone (dotted). The right side of the picture (superficial level), the left side (deep level).
D= 2, pp= 8, ps= 9 (X= 120).

1

3a



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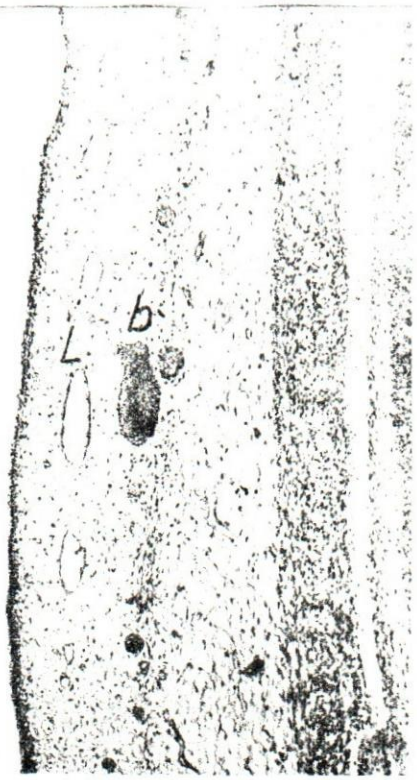

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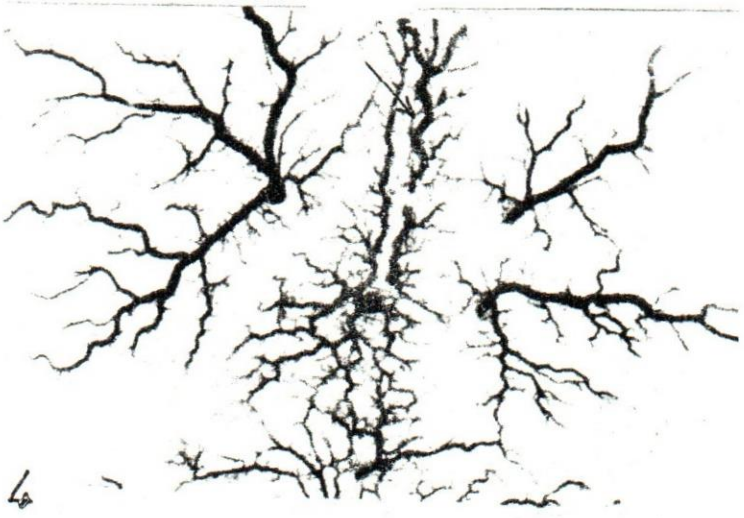

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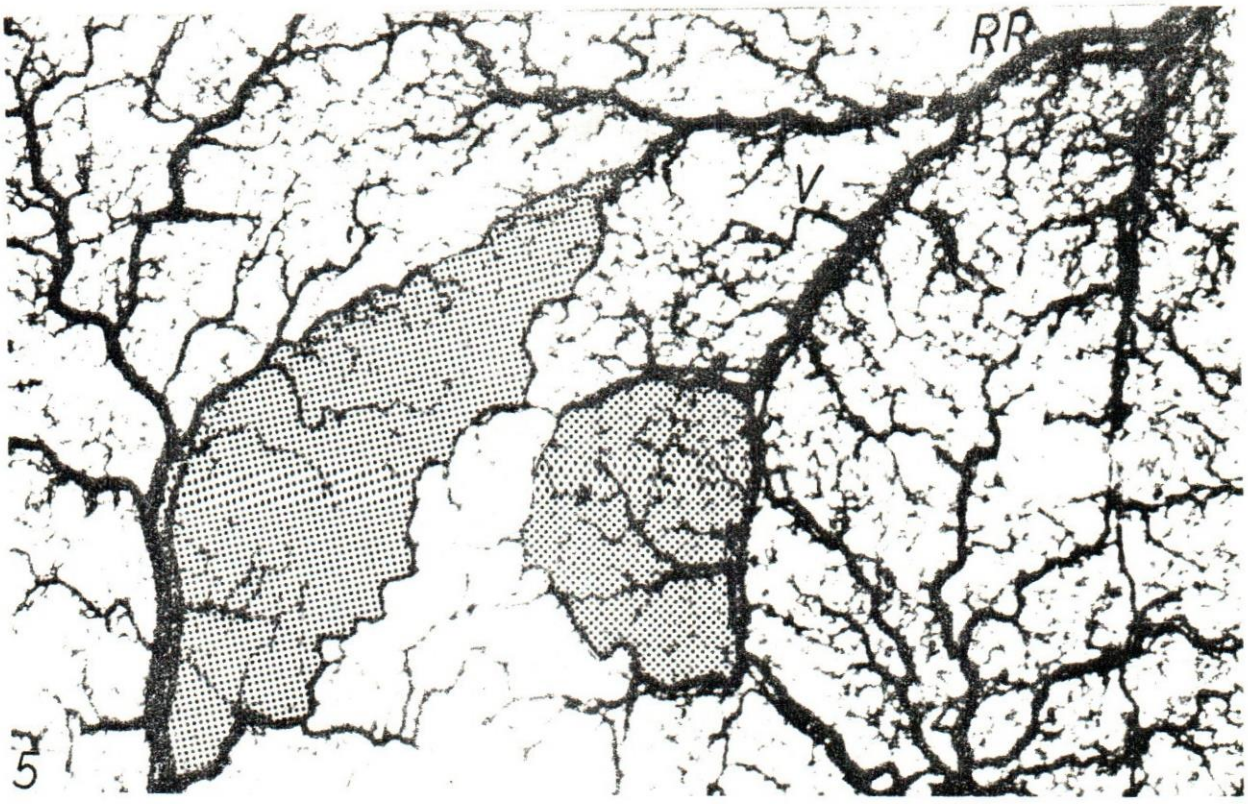

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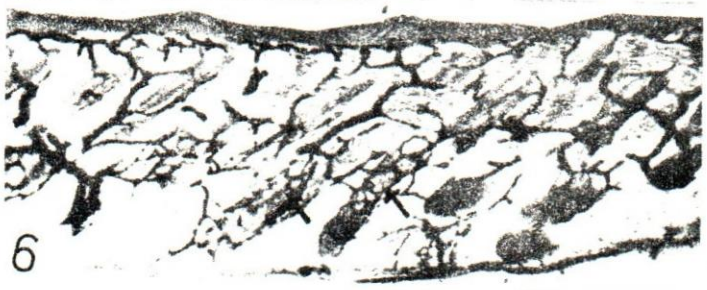

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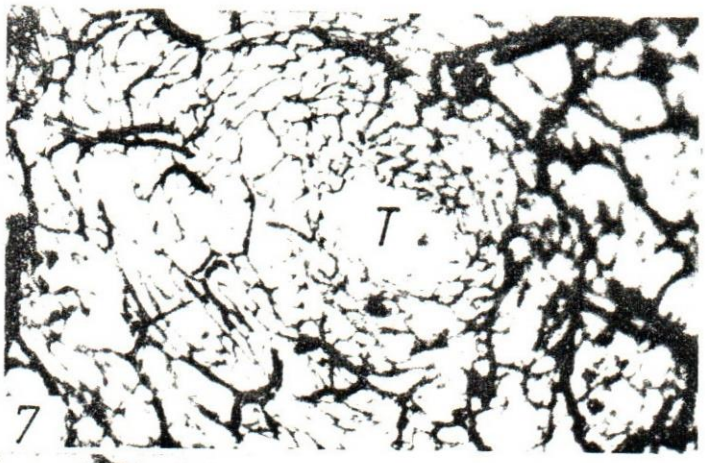
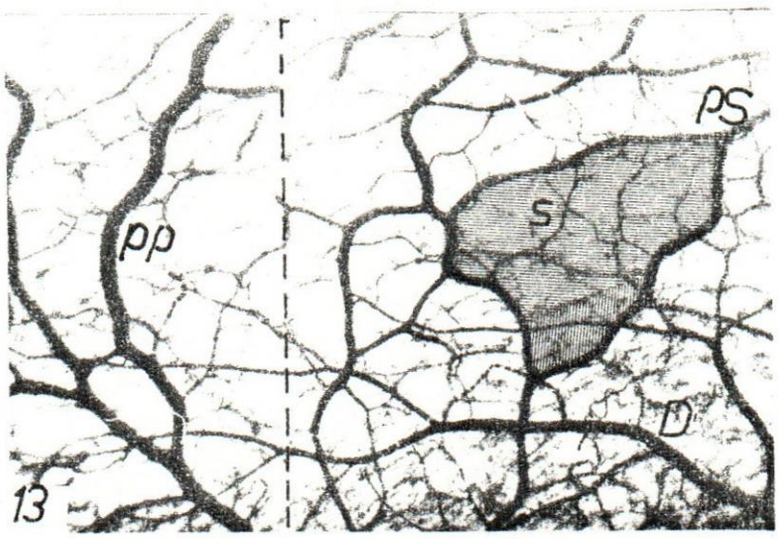


7

8

12a

12b



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