قسم : التشريح والهستولوجيا .
كلية : الطب البيطرى - جامعة أسيوط .
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منبع وتوزيع الشرايين المخيه والمخيخيه

في الأرنب

أحمد قناوى

يصل الدم الشرياني الى مخ الارنب عن طريق كل من الشريان السباتي الداخلي والشريان القاعدى .

هذا وينقسم الشريان السباتي الداخلي الى الشريان المخي الأمامي والشريان الموصل الخلفي ويغذى كل من الجزئين الأمامي والأوسط من المخ ، أما الشريان القاعدى فانه يتكون من اتحاد كل من الشريان فقارى الأيمن والايسر ويغذى كل من المخيخ ، القنطرة ، النخاع المستطيل والزوج الخلفي من الاقسام التواميه الأربعة. هذا وقد وجد أن الشريان القاعدى ينقسم في نهايته الى الشريانان المخيخان الاماميان الذين يتحدان مع الشريانان الموصلان الخلفيان النابعان من الشريان السباتي الداخلي ليكملوا جميعا الدائرة المخيه الشريانيه.

هذا وقد وجد أن التفرعات القشرية للشرايين المخيه الاساسيه (الأمامي والأوسط والخلفي) تتغمم مع بعضها ، وهذا يتحدث أيضا بين تفرعات الشرايين المخيخيه.

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ORIGIN AND DISTRIBUTION OF THE CEREBRAL AND CEREBELLAR ARTERIES OF RABBIT

(With 9 Figures)

By
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SUMMARY

The brain of rabbit receives its arterial blood from the internal carotid and basilar arteries. The internal carotid artery is well developed and bifurcates into the rostral cerebral and caudal communicating arteries which are responsible for the vasculature of the Prosen- and Mesencephalon. The basilar artery is also well developed and vasculrises the cerebellum, pons, medulla oblongata and the caudal colliculi. The basilar artery divides in rabbit into the two large rostral cerebellar arteries which join the rather smaller caudal communicating arteries to complete the caudolateral part of the cerebral arterial circle. The middle cerebral artery is a branch from the rostral cerebral, while the caudal cerebral is detached from the caudal communicating artery.

The main cerebral arteries anastomose with each other through their cortical branches, the same occured also between the cerebellar arteries.

INTRODUCTION

The arteries of the brain in mammals were described by TANDLER (1899), HOFMANN (1900), HAFFERL (1933), in dog by MILLER/ CHRESTENSEN/ EVANS (1964), HABERMEHAL (1973) and in other domestic animals by NANDA (1975), SEIFERLE (1975) and SIMOENS/ DE VOS/ LAUWERS (1978/79). However, the only available informations about the arterial supply of the brain of rabbit were given by WHITEHOUSE/ GROVE (1962) and WELLS (1964).

The present work aims to give a complete account on the origin and distribution of the cerebral and cerebellar arteries of the rabbit, in addition to the formation of the cerebral arterial circle in a comparative manner to other small animals and man.

MATERIAL and METHODS

The present study was carried out on 18 adult rabbits (Oryctolagus cuniculus) of both sexes and of different ages. The animals were anaesthetized by chloroform in a suitable glass box, bled through the common carotid artery then injected with 10% formalin solution.

Twelf of these animals were injected through the same artery with red coloured gum-milk Latex, while the otheres were injected by 1 : 1 bovine serum-indian ink solution till the skin became black. Dissection was carried out on the Latex injected specimens, while the serum-indian ink injected animals were first fixed in formalin solution.

Brains were dissected out and treated by ascending grades of alchol, benzin and methyl benzoate. Two additional animals were injected by Technovit 7001* then treated by conc. Hcl to obtain a Resin-cast of the injected arteries. The Nomenclature used is that proposed by the Committee of the NOMINA ANATOMICA VETERINARIA (1983).

RESULTS

The brain of rabbit receives its arterial blood from the internal carotid and basilar arteries, both are well developed and join each other at the caudolateral angles of the cerebral arterial circle.

A. carotis interna :

The internal carotid arery (1/1,2,3,4,6) reaches the cranial cavity through the For. lacerum rostrale and passes in a straight course, pierces the Diaphragma sellae and the cavernous sinus to lie lateral to the infundibulum of the Hypophyis cerebri, where it bifurcates into the nearly equal rostral cerebral and caudal communicating arteries.

The rostral cerebral artery (2/ 1,2,3,4,6,7) passes rostrad lateral to the infundibulum and Tuber cinereum where it detaches the middle cerebral artery at a level with the optic chiasma. it then curves dorsal to the corresponding optic nerve to enter the cerebral longitudinal fissure where it continues its course within the interhemispheric space. The rostral cerebral artery joins its fellow of the other side before they enter the cerebral longitudinal fissure through the rostral communicating artery (5/ 1,3).

The rostral communicating artery may be double-formed as was seen in one examined case (3 B) or might be absent as was observed in another specimen in which the two rostral cerebral arteries fused together to form a single vessel which was soon bifurcated (3 A). The rostral cerebral artery gives off the rostral choroidal artery which passes along the corresponding optic tract to share in the vasculture of the choroid plexus of the third ventricle.It also detaches the internal ophthalmic (17/ 2,3; 6/ 6) and the internal ethmoidal arteries (4/1; 5/ 5,6). The former accompanies the dorsolateral aspect of the optic nerve into the orbit, while the latter anastomoses with twigs from the external ethmoidal artery and both form the arterial ethmoidal plexus. The rostral cerebral artery supplies the Tuber cinereum, rostral part of Hypophysis, optic chiasma, olfactory trigone and tract and detaches central perforating branches for the Corpus striatum, Corpus callosum and cortical branches for the Hippocampus and the cerebral cortex which lies medial to the Vallecula cerebri (1/8 D). The cortical branches of the rostral cerebral artery anastomoses with similar branches from the middle and caudal cerebral arteries.

The middle cerebral artery (3/ 1,2,3; 7/ 5,6) passes laterally just rostral to the piriform lobe, crosses the lateral olfactory tract to reach the lateral cerbral fissure (Sylvian) where it ascends to supply the lateral and dorsal portions of the cerebral cortex through its cortical branches (7', 7" / 7). In addition it gives off several central branches which vascularize

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* : Technovit 7001 is a Resin, cold-curing produced by Kulzer & Co., GmbH, D 638 Bad Homburg, West germany.

the piriform lobe, caudal part of the lateral olfactory tract, olfactory trigone and Corpus striatum. The branches of the middle cerebral artery anastomose with the cortical twigs of the caudal cerebral artery and with those of the rostral cerebral along the lateral aspect of the Vallecula.

The caudal communicating artery (7/ 1,2,3; 8/ 4,6) is a considrable branch and constitutes the second terminal branch of the internal carotid artery. It passes caudolterally between the cerebral crus and piriform lobe where it joins the corresponding rostral cerebellar artery (15/ 1,2,3; 17/ 4,6) and continues as the caudal cerebral artery. In only one dissected case, the left caudal communicating artery joined a branch from the right rostral cerebellar artery (3 C). The caudal communicating artery detaches several fine twigs for the cerebral crus and a considrble branch which terminates in he lateral side of the mamillary body and Hypophysis cerebri.

The caudal cerebrl artery (9/ 6) is a considrable branch which ascends lateral to the corresponding cerebral crus, hidden by the caudolateral portion of the cerebral hemisphere and continues along the free border of the parahippocampal gyrus where it distributes. The caudal cerebral artery vascularizes the deep surface of the piriform lobe, hippocampus and caudolateral portion of the cerebrum. Its cortical branches appear from the transverse cerebral fissure and anastomose with those of the rostral and middle cerebral arteries (8 B,D). Shortly after its origin, the caudal cerebral artery gives off a considerable branch which soon divides into two unequal branches. The smaller rostral branch is the caudal choroidal artery (10/ 6) which passes rostromedially to share in the vasculature of the epithalamic area, pineal body and the choroid plexus of the third ventricle. The larger caudal branch supplies the well developed rostral colliculus, thalamus, and geniculate bodies, its rostral twigs anastomose with those of the caudal choroidal artery, while its caudal branches join twigs from the artery of the inferior colliculus of the rostral cerebellar artery (18/ 6).

A. basilaris :

The basilar artery (8/ 1,2,3; 12/ 4,5,6) results from the union of the right and left vertebral arteries (9/ 1) at a level with the For. magnum. At the rostral border of the Pons it divides into the right and left rostral cerebellar arteries (15/ 1,2,3; 17/ 4,6).

The basilar artery gives off 2 - 3 large pontine branches, the rostral one detaches a branch for the trigeminal nerve, while the caudal one detaches several fine twigs along a shallow transverse groove between the pons and corpus trapezodium. Just caudal to the last pontine branch, the basilar artery gives off the caudal cerebellar artery (12/ 1,2; 15/ 5,6,7) which distributes in the caudal part of the cerebellum, restiform bodies, choroid plexus of the fourth ventricle and anastomoses with branches from the rostral cerebellar and basilar arteries. It also detaches the auditory artery (13/ 1; 16/ 5,6) which accompanies the eighth cranial nerve.

The basilar artery vascularizes the medulla oblongata through 5 - 6 considrable branches (11/ 1; 13/ 5,6,7), in addition to 8 - 10 small ones given off along its course within the shallow ventral median fissure (Fig. 9).

The rostral cerebellar arteries (15/ 1,2,3; 17/ 4,6) represents the two terminal branches of the basilar artery. Each passes laterad along the rostral border of the pons where it joins the rather smaller corresponding caudal communicating artery, then ascends along the rostral border of the brachium pontis. As it reaches the ventral surface of the cerebellum, the rostral cerebellar artery divides into medial and lateral equal branches. The medial branch

(20/ 6,7) curves medially just caudal to the anterior medullary velum then caudally between the body and cerebellar hemisphere to terminate by anastomosing with its fellow of the other side and with twigs from the lateral branch (19/ 5,6,7) and caudal cereballar artery. It also forms an arterial plexus together with the medial branch of the other side on the tentorial surface of the cerebellum.

The lateral branch of the rostral cerebellar artery (13/ 5; 19/ 6,7) courses caudally dorsal to the Flocculus after detaching a branch which passes ventral to the same flocculus, they anastomose with branches from the caudal cerebellar artery to supply the cerebellar hemisphere and share in the vascualture of the choroid plexus of the fourth ventricle.

At its origin, the rostral cerebellar artery detaches 3 - 4 twigs for the caudal part of the hypophysis cerebri and mamillary body, 2 - 3 twigs for the adjacent part of the cerebral crus and a considrable one for the brachium pontis. In addition, the rostral cereellar artery supplies the caudal colliculus through a considrable branch (18/6) which anastomose with twigs from the artery of the rostral colliculus of the caudal cerebral artery.

DISCUSSION

The cerebral and cerebellar arteries in the rabbit originate essentially from the internal carotid and vertebral (basilar) arteries, both are well developed in rabbit as in the case of man (HOUSE/ PANSKY, 1960, TRUEX/ CARPENTER, 1969 and WILLIAMS/ WARWICK 1980) and in dog (MILLER/ CHRESTENSIN/ EVANS, 1964; HABERMEHL, 1973 and SEIFERLE, 1975).

The internal carotid artery in rabbit bifurcates ino the rostral cerebral and caudal communicating arteries, while in dog it trifurcates into the rostral, middle cerebral and caudal communicating arteries as observed by MILLER et al. (1964) JENKINS (1972) and HABERMEHL (1973). The same trifurcation was reported also by HOUSE/ PANSKY (1960) in man.

The internal carotid artery divides into Ramus anterior and posterior (TANDLER, 1899); R. cranialis and caudalis (HOFFMANN, 1900), or rostral and caudal divisions (GILLILAN, 1974). However, NANDA (1975) mentioned that the internal carotid artery detaches the caudal communicating artery and terminates by dividing into the rostral and middle cerebral arteries. SEIFERLE (1975) and SIMOENS et al. (1978/79) stated that the internal carotid artery divides into the rostral cerebral and caudal communicating arteries as in rabbit. The rostral cerebral artery is the more suitable name for this vessel from its origin till it gives off its terminal branches between the two cerebral hemispheres in regard to its position, course and area of supply. Moreover, the name rostral cerebral artery must replace all other previous names (A. corporis callosi; TANDLER, 1899; A. cerebri anterior azygos: GILLILAN, 1974; common or median artery of corpus callosum: NANDA, 1975; common stem of Aa. corpores callosi: HABERMEHL, 1973 and A. communicans rostralis: SEIFERLE, 1975).

The middle cerebral artery in rabit has a constant origin from the rostral cerebral artery at a level with the optic chiasma. However, SIMOENS et al. (1978/79) mentioned the rostral cerebral, as well as, the cerebral arterial circle as parent vessels for the middle cerebral artery.

The rostral communicating artery found in rabbit is identical with the homonemous artery described by SIMOENS et al. (1978/79).

CEREBRAL AND CEREBELLAR ARTERIES

The cerebral arterial circle is responsible for constant normal blood streem for the cerebral arteries, in addition, the circle makes possible an adequate blood supply to the brain in case of occlution of either the carotid or vertebral arteries as reported by HOUSE/ PANSKY (1960) in man.

The rostral boundary of the cerebral arterial circle in the rabbit is formed either by the rostral communicating artery in most cases or by the rostral union between the two rostral cerebral arteries in the cases where the rostral communicating artery was absent.

The caudal boundary of the cerebral arterial circle in the rabbit is formed by the two large diverging terminal branches of the basilar artery which join the rather smaller caudal communicating of the internal carotid artery. This result is identical with that reported in man as the caudal cerebral arteries (the terminal branches of the basilar artery) form the caudal boundary of the cerebral arterial circle, however in dog the caudal communicating arteries join each other to form the caudal convex boundary of the circle as stated by HABERMEHL (1973), SEIFERLE (1975), NANDA (1975) and SIMOENS et al. (1978/79).

The arterial anastomoses found between the branches of the caudal cerebral and rostral cerebellar arteries in rabbit are of high significance as those demonstrated between the posterior cerebral and other arteries in man by HOUSE/ PANSKY (1960), TRUEX/ CARPENTER (1969) and WILLIAMS/ WARWICK (1980), as in this case, these anastomoses repfesen another connection between the blood of the basilar and internal carotid systems.

However, TRUEX/ CARPENTER (1969) pointed out that these anastomoses usually are not sufficient to maintain adequate circultion if a major vessel is occluded suddenly.

The topographic boundary between the cortical branches of the rostral cerebral and those of the middle and caudal cerebral arteries given by HABERMEHL (1973) is the sulcus marginalis. This boundary is represented in the brain of rabbit by the sagittal vallecula, which may be considered as the primitive form of the marginal sulcus found in the more higher mammals.

The flexeous course of the cerebral arteries in mammals must be correlated in correspond to the degree of evolution of the cerebral gyri and sulci. in this respect, the brain of rabbit is lissencephalic and the major cerebral arteries and their branches run in an almost straight course, this pattern indicates that the rabbit forms one of the primitive mammals as described by AHMED (1985).

The intracavernous and the supraclinoid portions of the internal carotid artery in man are referred to as the carotid siphon by Neuroradiologists (TAVERAS/ WOOD, 1964). HABERMEHL (1973) reported that several investigators mentioned that the carotid syphon decreases the blood pressure which may increase suddenly by the arterial blood waves. However, the carotid siphon (loop) was not observed in any examined rbbit specimen. PLAZER (1956) recorded the absence of the carotid loop also in most primates and in some cases in man. In these cases; the function of the carotid loop (when it is absent) may be done by the cerebral arterial circle, however, FOCHS (1925) demonstrated that the carotid loop has no essential effect on the cerebral blood circulation.

The richly distributed capillaries in the medulla oblongata and the mesencephalic colliculi proove the statment of LIERSE (1963) that the sensory nuclei areas of the medulla oblongata and high brain centers in mammals are richly supplied with capillaries than the motor centers.

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LEGENDS

Fig. (1): Arteries of the brain of rabbit Technovit cast of the arteries of the brain, A. ventral view, B. left lateral view, C. Diagram showing the branches of the internal carotid and basilar arteries, ventral view.

Fig. (2): Cerebral arterial circle (normal pattern)
A. Latex-indian Ink injected specimen.
B. Diagram showing the arteries of the cerebral circle.

Fig. (3): Diagram showing the variations in the formation of the cerebral arterial circle in rabbit
General key for Figures 1, 2, 3.
a. mamillary body, b. optic chiasma, c. trigeminal nerve.
1. internal carotid artery, 2. rostral cerebral, 3. middle cerebral, 4. internal ethmoidal, 5. rostral communicating, 6. central branches, 7. caudal communicating, 8. basilar, 9. vertebral, 10. ventral spinal, 11. medullary branches, 12. caudal cerebellar, 13. auditory, 14. pontine branches, 15. rostral cerebellar, 16. artery of caudal colliculus, 17. internal ophthalmic artery.

Fig. (4): Diagram showing the arteries at the mid-sagittal section of the brain, left aspect.

Fig. (5): Diagram showing the arteries of the lateral aspect of the brain, left side.

Fig. (6): Diagram showing the arteries of the left side of the brain after removal of the left cerebral hemisphere.

Fig. (7): Diagram showing the distriution of the cerebral and cerebellar arteries on the dorsal aspect of the brain.
General key for Figures 4, 5, 6, 7.
a. rostral colliculus, b. caudal colliculus, c. vermis, d. cerebellar hemisphere, e. flocculus, f. vallecula, g. lateral groove, h. rhinal sulcus, i. trigeminal nerve, j. optic nerve.
1. internal carotid artery, 2. left; 2'. right rostral cerebral, 3. central branches, 4. cortical branches, 5. internal ethmoidal, 6. internal ophthalmic, 7. middle cerebral, 7'. rostral branch, 7''. caudal branch, 8. caudal communicating, 9. caudal cerebral, 10. caudal choroidal, 11. artery of rostral colliculus, 12. basilar, 13. medullary branches, 14. pontine branches, 15. caudal cerebellar, 16. auditory, 17. rostral cerebellar, 18. artery of coudal colliculus, 19. lateral branch, 20. medial branch of rostral cerebellar artery.

Fig. (8): Diagram showing the area of supply of the cerebral and cerebellar arteries of rabbit

A. ventral aspect, B. midsagittal, C. lateral, D. dorsal aspect.

1. rostral cerebral artery, 2. middle cerebral, 3. caudal communicating,
4. caudal cerebral, 5. basilar, 6. rostral cerebellar, 7. caudal cerebellar artery.

Fig. (9): Pontine (p) and medullary (m) branches of the basilar artery,

A. Latex-indian ink injected specimen.

B. 0.2 mm mid-sagittal section of a bovine serum-indian ink injected specimen, X 10.

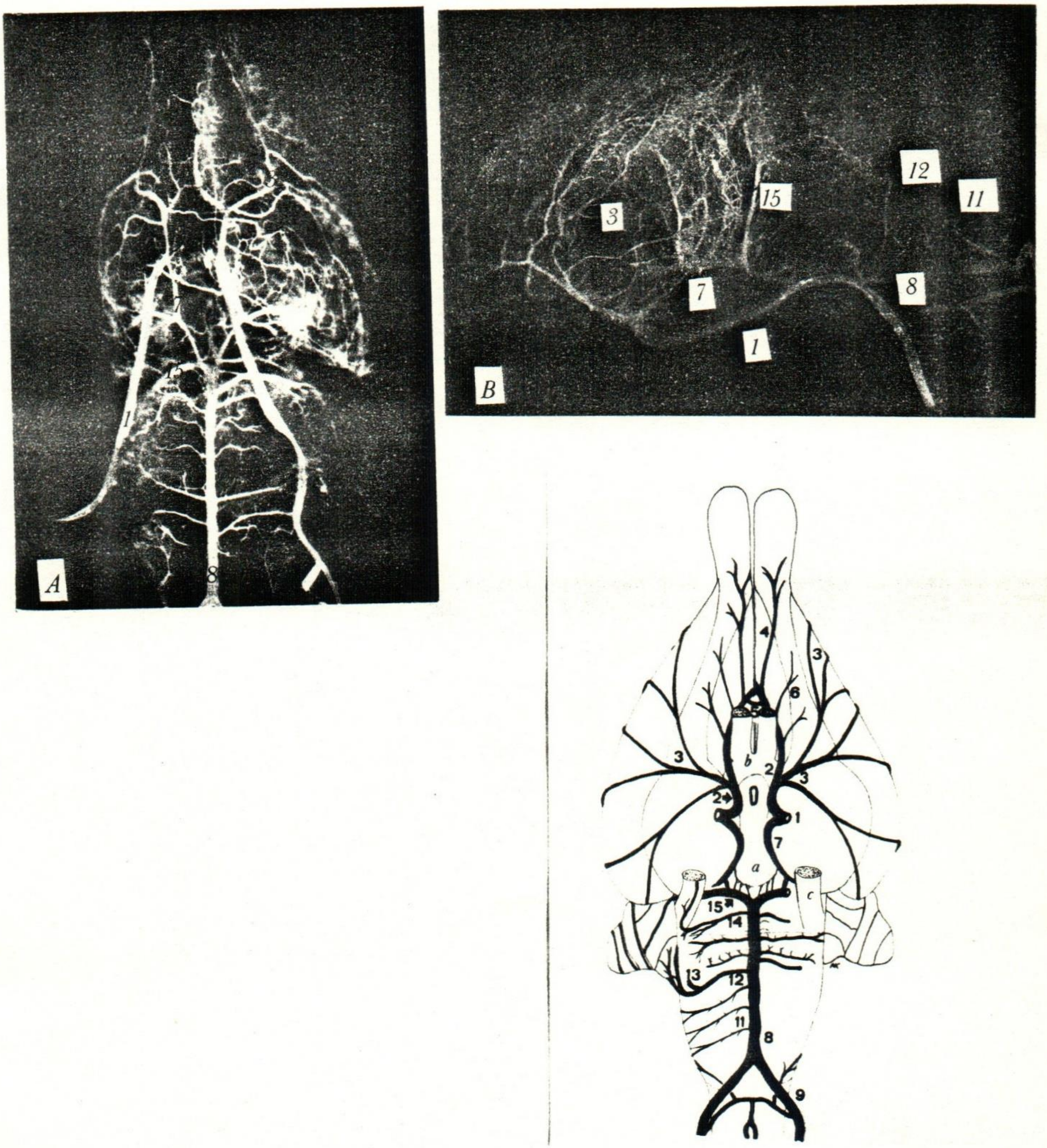

Fig. (1): Arteries of the brain of rabbit

Technovit cast of the arteries of the brain,
A ventral view, B left lateral view
C Diagram showing the branches of the internal carotid and basilar arteries, ventral view

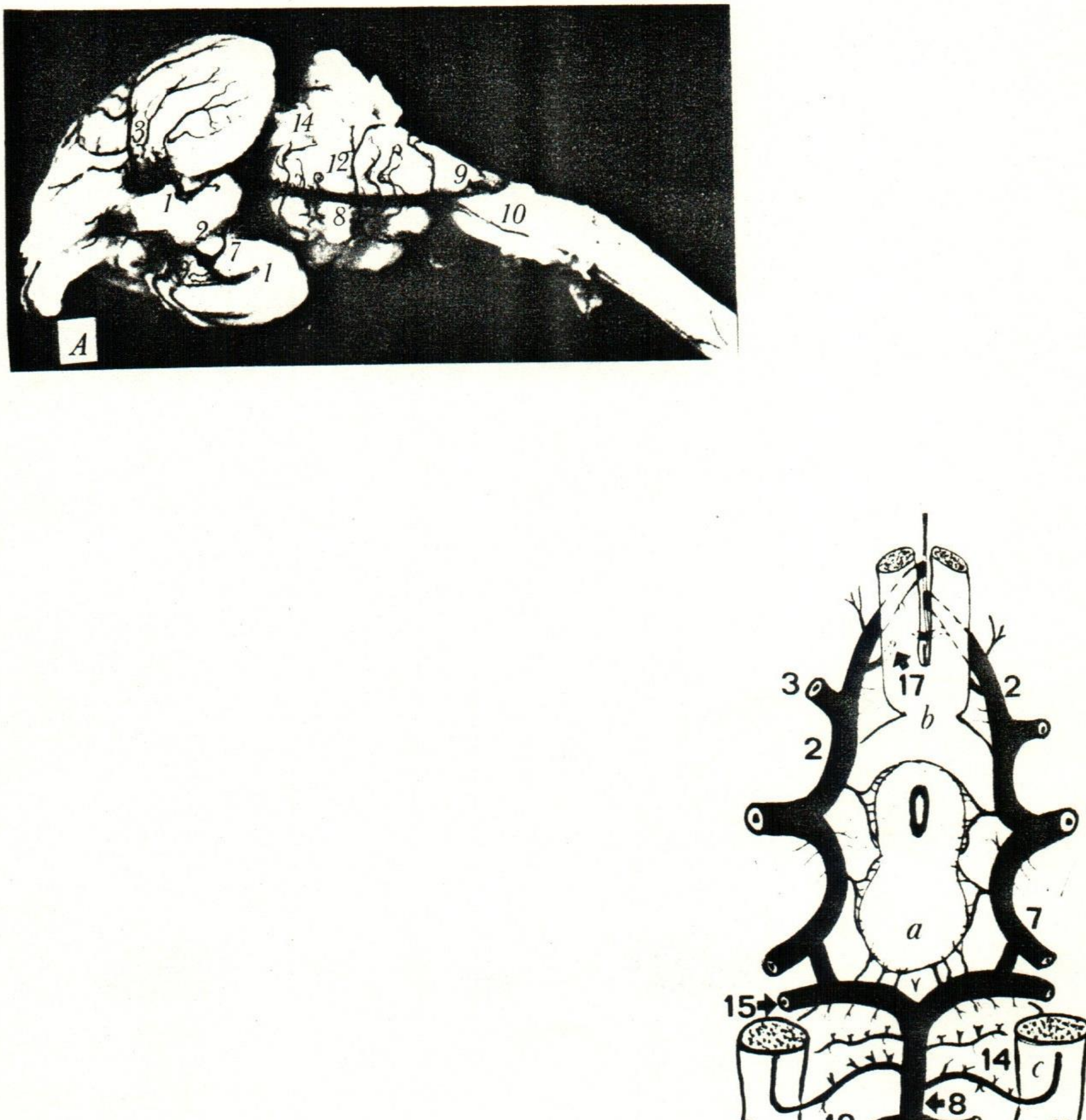

Fig. (2): Cerebral arterial circle (normal pattern)
A Latex-indian Ink injected specimen
B Diagram showing the arteries of the cerebral circle

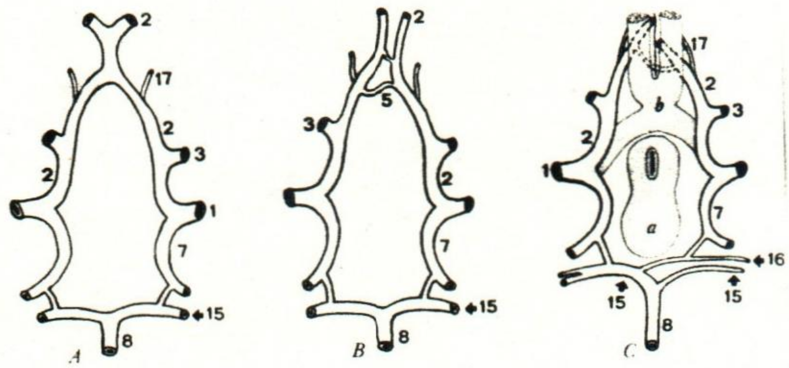

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Fig. (3): Diagram showing the variations in the formation of the cerebral arterial circle in rabbit

General key for Figures 1, 2, 3

a mamillary body, b optic chiasma, c trigeminal nerve

1 internal carotid artery, 2 rostral cerebral, 3 middle cerebral, 4 internal ethmoidal, 5 rostral communicating, 6 central branches, 7 caudal communicating, 8 basilar, 9 vertebral, 10 ventral spinal, 11 medullary branches, 12 caudal cerebellar, 13 auditory, 14 pontine branches, 15 rostral cerebellar, 16 artery of caudal colliculus, 17 internal ophthalmic artery.

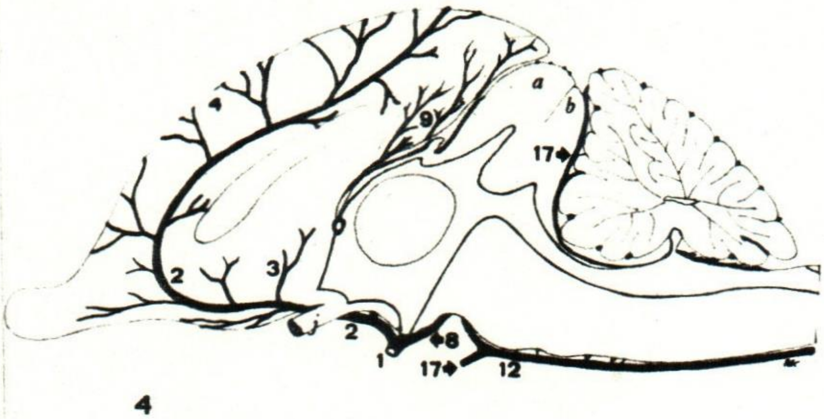

Fig. (4): Diagram showing the arteries at the mid-sagittal section of the brain, left aspect

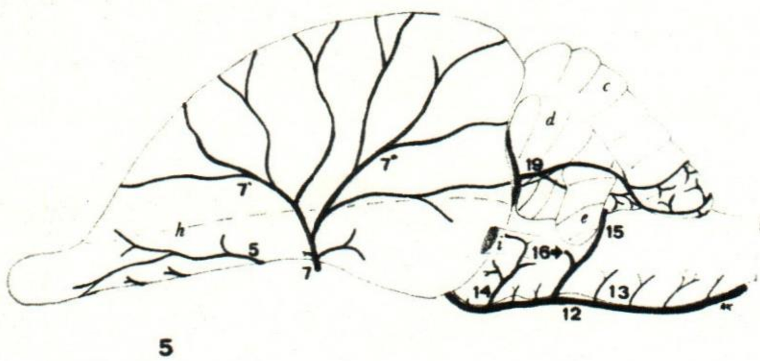

Fig. (5): Diagram showing the arteries of the lateral aspect of the brain, left side

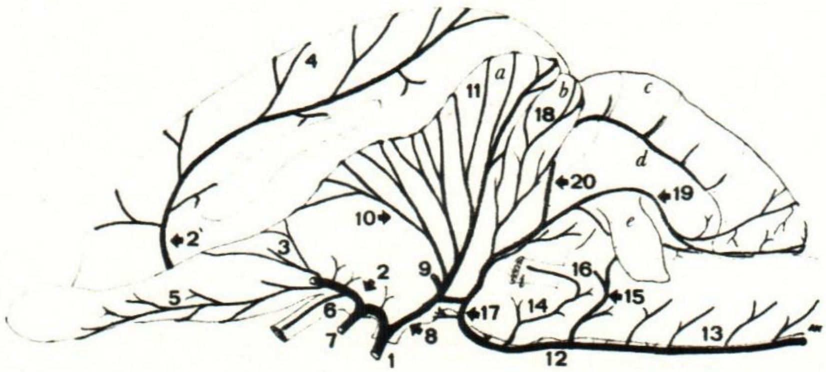

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Fig. (6): Diagram showing the arteries of the left side of the brain after removal of the left cerebral hemisphere

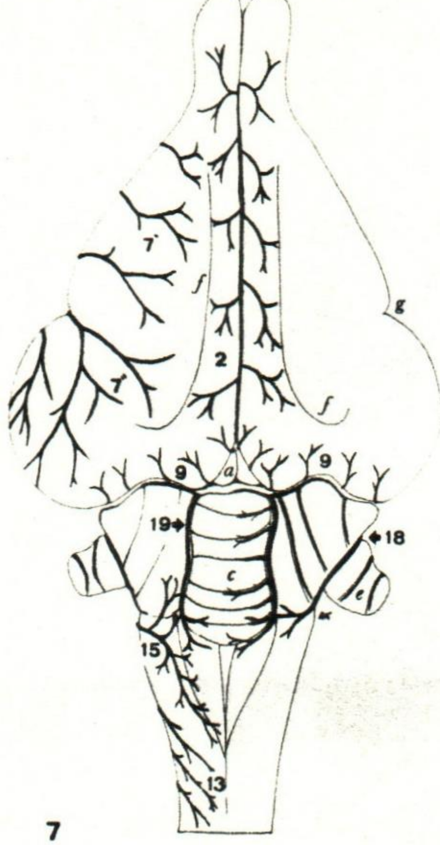

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Fig. (7): Diagram showing the distribution of the cerebral and cerebellar arteries on the dorsal aspect of the brain of rabbit

General key for Figures 4, 5, 6, 7

a rostral colliculus, b caudal colliculus, c vermis, d cerebellar hemisphere, e flocculus, f vallecula, g lateral groove, h rhinal sulcus, i trigeminal nerve, j optic nerve

1 internal carotid artery, 2 left; 2' right rostral cerebral, 3 central branches, 4 cortical branches, 5 internal ethmoidal 6 internal ophthalmic, 7 middle cerebral, 7' rostral branch, 7'' caudal branch, 8 caudal communicating, 9 caudal cerebral, 10 caudal choroidal, 11 artery of rostral colliculus, 12 basilar artery, 13 medullary branches, 14 pontine branches, 15 caudal cerebellar, 16 auditory, 17 rostral cerebellar, 18 artery of caudal colliculus, 19 lateral branch, 20 medial branch of rostral cerebellar artery.

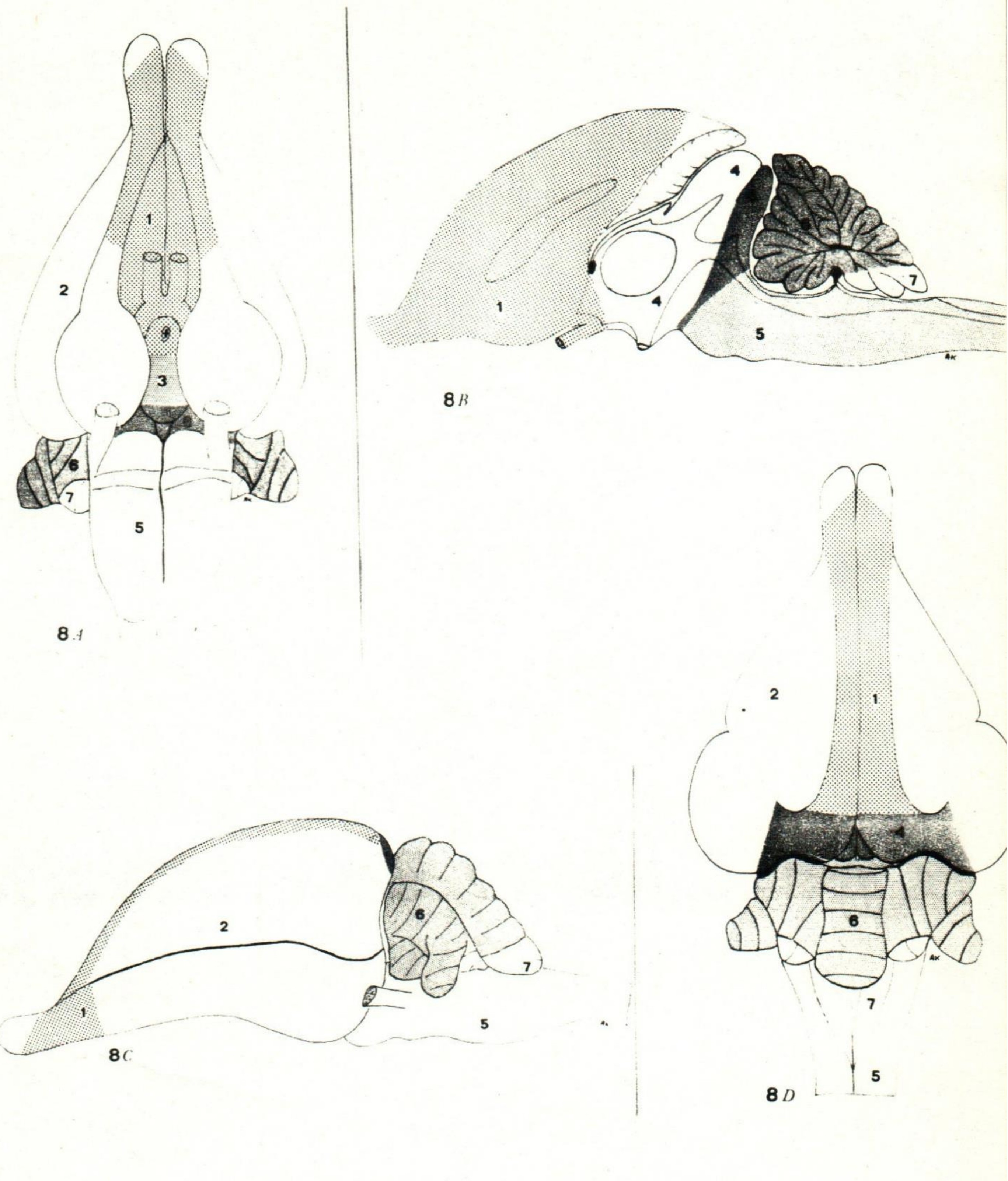

Fig. (8): Diagram showing the area of supply of each of the cerebral and cerebellar arteries of rabbit

A ventral, B mid-sagittal, c lateral, D dorsal aspect

1 rostral cerebral artery, 2 middle cerebral, 3 caudal communicating, 4 caudal cerebral, 5 basilar, 6 rostral cerebellar, 7 caudal cerebellar artery.

Fig. (9): Pontine (p) and medullary (m) branches of the basilar artery,
A Latex-indian Ink injected specimen
B 0.2 mm mid-sagittal section of a bovine serum-indian Ink injected specimen, X 10