Int. J. Morphol.,
***34(4)*:**1429-1435, 2016.

Morphometric Study of the Rostral Epidural Rete Mirabile in the Dromedary (*Camelus dromedarius*, Linnaeus 1758)

Estudio Morfométrico de la Rete Mirabile Epidural Rostral en el Dromedario (*Camelus dromedarius*, Linnaeus 1758)

Hassen Jerbi*; Sana Khaldi* & William Pérez**

JERBI, H.; KHALDI, S. & PÉREZ, W. Morphometric study of the rostral epidural rete mirabile in the dromedary (*Camelus dromedarius*, Linnaeus 1758)**.** *Int. J. Morphol., 34(4)*:1429-1435, 2016.

SUMMARY: In camels, the rostral epidural rete mirabile had a spongy appearance, and consisted of a dense network of anastomosing arteries occupying the entire cavity of the cavernous sinus. In this study, we measured the length of each rostral epidural rete mirabile lobe, taken between the rostral and the caudal roots dissected in situ before spreading and after reconstitution, and the total length of the rostral epidural rete mirabile after linear reconstitution. The length of the left lobe of the rete was 6.0±0.4 mm and the length of the right lobe was 5.8 ± 0.5 mm. The combined length of the RERM after separation of the arteries was 305.2±9.7 cm. To conclude, we added information to literature in relation to morphometry of the camel RERM and showed this interesting structure with photographic documentation of dissections with latex injection in arterial and venous vessels.

KEY WORDS: Anatomy; Arteries; Brain; Camel; Encephalon; Vascular system.

INTRODUCTION

The rostral epidural rete mirabile (RERM) is a voluminous mass with a spongy aspect, occupying all the cavernous sinus. It consists of a dense network of countless anastomosing arteries inside the skull of the artiodactyls (Uehara *et al*., 1978; Khamas & Ghoshal, 1985; Ocal & Aslan, 1994; Ocal *et al*., 1998; Wang *et al*., 2012). Several studies were conducted on the structure and function of the RERM in different animal species, including camelids. In some artiodactyls such as cattle, goats, sheep, RERM is the unique source of arterial supply to the encephalon, since the internal carotid artery in its proximal part, remains vestigial or may even be absent (Ocal *et al*., 1998). In other artiodactyls such as the small kanchil of Java (Tragulus javanicus), this network is completely absorbed to lead to an important development of the internal carotid artery, like in horses and carnivores, and is the only feeding artery of the encephalon. In camels (*Camelus dromedarius*), the encephalic arteries were described by Kanan (1970) and RERM receives the blood flow from the proximal part of a major internal carotid artery, multiple branches of the maxillary artery and the external ophthalmic artery (Zguigal & Ghoshal, 1991a; Ocal *et al*., 1998, 1999). Other anatomical studies of RERM in dromedary camel were carried out for some authors (Zguigal & Ghoshal 1991a, 1991b; Kieltyka-Kurc *et al*., 2014) and the physiology was described by Elkhawad (1992) and Mitchell *et al*., (2002). The diameters of the vesssels were studied by Ocal *et al*. (1998). In the bactrian camel, Wang (1989) described similar disposition to the dromedary.

Since the Eocene, the diversity of artiodactyls has increased while that of perissodactyls has decreased. Artiodactyls can be found on all continents (except for Antarctica) and are known to inhabit all environments, such as desert, tundra and high mountains. These animals have a suite of physiological specializatons that are very important for adaptation to extreme environments.

Mitchell & Lust (2008) suggested that evolution of a carotid rete, a structure highly developed in artiodactyls but absent in perissodactyls, was important for obtaining better adaptation and evolutionary success. According to these

* Service d'Anatomie, Ecole Véterinaire Sidi Thabet. CP 2020, Tunisie.
** Área de Anatomía, Facultad de Veterinaria, Lasplaces 1620, 11600 Montevideo, Uruguay

authors the rete confers an ability to regulate encephalon temperature independently of body temperature. In perissodactyls, brain and body temperature change in parallel and thermoregulation requires abundant food and water to warm/cool the body. Consequently, perissodactyls occupy habitats of low seasonality and rich in food and water, such as tropical forests. The increased thermoregulatory flexibility of artiodactyls has facilitated invasion of new adaptive zones ranging from theArctic Circle to deserts and tropical savannahs (Mitchell & Lust).

These authors indicated that at least three known functions can be attributed to it, one is the regulation of blood flow and pressure to the encephalic circulation; another is temperature regulation and finally the rete can facilitate transfer of substances from venous blood coming from the nasal mucosa to the hypophysis.

The aim of this work was establish a morphometric study of the REMR in the dromedary, using plan-by-plan classic progressive dissection, first in situ, maintaining the RERM within its connexions to the cerebral aterial circle (Willis circle), the proximal part of the internal carotid artery, the multiple branches of the maxillary artery and the external ophthalmic artery; then isolating it by section of the distal portion of the internal carotid artery and spreading itona horizontal plan to reconstruct it in rectilinear segments to measure its total length. In addition we determine the organization of the arteries and arterioles of the RERM and their layout regarding all the cerebral veinous sinus, using transverse and sagittal sections. This would allow a better comprehension of the role of the RERM in the thermoregulation and the encephalic hemodynamics in the dromedary.

MATERIAL AND METHOD

This study involved the use of 7 camel heads (4 males and 3 females) aged between 1 and 1.5 years. The specimens were handled and treated according to the local Ethical Board guidelines of Ecole Véterinaire Sidi Thabet of Tunisia. A first group of 5 heads was used to perform plan-by-plan classical progressive dissections, that allowed the extraction of the encephalon within its connections to the RERM and venous blood vessels. In order to identify the organization of the arterial network and to measure its density in arteries and arterioles, a second group composed of 2 injected heads with 10 % formalin solution and frozen at -22°C was used. In these two heads, transverse sections on one and sagittal sections on the other were performed. These were carried with a JS600 bandsaw.

Each head of the first group was isolated immediately after slaughter by a C2-C3 section. The head and the cranial extremity of the neck were injected with a 10 % formalin solution via cannulas placed in the common right and left carotid arteries. Fixation takes 12 to 24 hours, and then, demineralized water was introduced through the same cannulas to wash the formalin salts. Between 60 and 100 ml of very diluted and red-colored latexneoprene was injected immediately after rinsing with demineralized water in both common carotid arteries. The injection of latex was conducted progressively with hand pressure, using 60 ml syringes, until the coloration of the little arterioles in the conjunctiva was visible. A very-diluted solution of blue-colored latex neoprene was also manually injected in the venous system through cannulas placed in each external jugular vein. Cannulas were systematically placed in a way to bypass the venous valves system of the external jugular vein, commonly located next to C1, in order to achieve a satisfactory filling. We used near 400 ml of latex neoprene for each head, and the injection was systematically stopped at the appearance of resistance. Heads were then maintained at +4 °C during 24 hours, until the solidification of the injected latex was suitable. A dissection was conducted progressively, following precise muscular incisions and bone sections, to extract the encephalon still linked to its RERM and venous sinuses. After isolating the encephalon, measures were taken using an universal caliper (Facom type, 1 mm precision). These measures are:

- LRERM represents the total length of each arterial lobe *in situ,* measured rostro-caudally.

- L1G, L2G, L3Gwere *in situ* widths of a lobe, respectively taken next to the rostral root (maxillary artery), the middle of the hypophysis and next to the caudal root (proximal part of the internal carotid artery) of the left lobe. These measures were systematically taken for the right lobe (Fig. 1) (Table I).

Regarding the second group, there was no previous injection for conservation was done and latex neoprene was directly introduced in the head in the same way than for the first group. The heads were conserved several days at -22 °C, before performing transverse and sagittal 1 cm-thick sections.

The lobe of each RERM had the aspect of a ball of arteries and arterioles. In a second step, it was isolated from its connections with the distal part of the internal carotid artery, then cut in a few millimeters segments, as linearly as possible. Afterwards, these segments were reconstructed on a horizontal plan into 10 cm portions, with the intention of measuring the total length of the arterial network of each RERM lobe (Fig. 2).

In this study, we measured (Table I) the length of each RERM lobe, taken between the rostral and the caudal roots dissected *in situ* before spreading and after reconstitution, of the 5 camel heads; and the total length of the RERM after linear reconstitution.

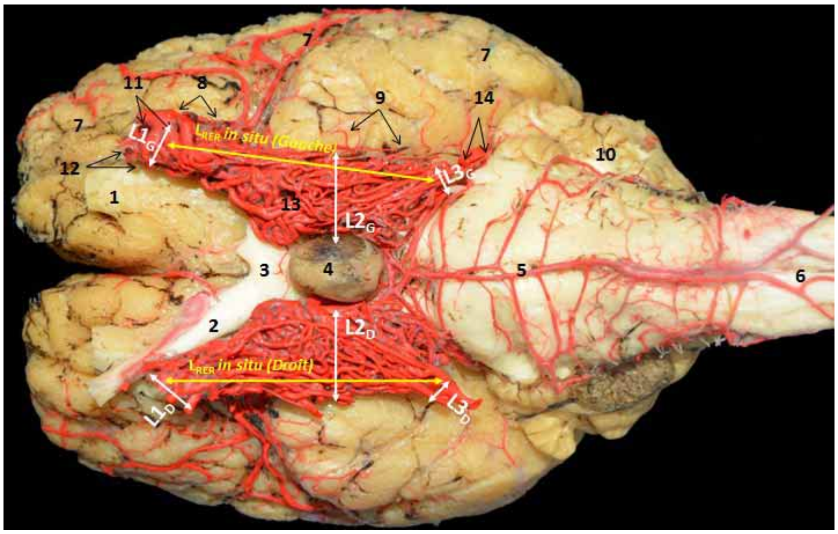

Fig. 1. Ventral view of the rostral epidural rete mirabile in the isolated encephalon of the dromedary. 1:Olfactory tract, 2:Optic nerve; 3:Optic chiasm; 4: Hypophisis pituitary; 5: Pons; 6:Spinal cord; 7: Telemcephalon; 8: Piriform lobe (rostral); 9: Piriform lobe (caudal); 10:Cerebellum; 11: Rostral epidural rete, rostral root (maxillary artery); 12:Rostral epidural rete, root of ophthalmic artery; 13: Rostral epidural rete; 14: Rostral epidural rete,caudal root (proximal part of the internal carotid artery); LRER *in situ* Gauche:Left part *in situ*; LRER *in situ* Droit:Right part *in situ*; L1G:Left lobe with blood of left maxillary artery; L1D:Right lobe with blood of right maxillary artery; L2G: Width of the left lobe of the rete next to the middle of the hypophysis; L2D: Width of the right lobe of the rete next to the middle of the hypophysis; 3GL: Width of the left lobe of the rete in the proximal part of the left internal carotid artery; L3D: Width of the right lobe of the rete in the proximal part of the right internal carotid artery.

Table I. Measurement of the rostral epidural rete mirabile in the dromedary camel.

	1	2	3	4	5	Mean ± SD
$L1_L$ (mm)	13.4	13.2	13.1	13.5	14.0	13.4±0.3
$L1_R$ (mm)	10.8	11.2	11.0	10.8	11.1	10.9± 0.1
$L2_L$ (mm)	19.6	20.9	20.8	20.4	19.8	20.3±0.5
$L2_R$ (mm)	20.2	21.8	21.5	20.6	21.0	21.0±0.6
$L3_L$ (mm)	4.0	4.2	4.2	4.0	4.1	4.1±0.1
$L3_R$ (mm)	4.1	4.4	4.7	4.1	4.3	4.3±0.2
L_{RER} *in situ*$_{Left}$ (cm)	5.4	6.2	6.6	5.8	6.0	6.0±0.4
L_{RER} *in situ*$_{Right}$ (cm)	5.2	6.0	6.8	5.7	5.6	5.8±0.5
L_{RER} *separation* $_{Left}$ (cm)	150.0	164.0	152.0	152.0	160.0	155.6±6.0
L_{RER} *s eparation* $_{Right}$	144.0	152.0	160.0	144.0	148.0	149.6±6.6
$\sum L_{RER}$ separation (cm)	294.0	316.0	312.0	296.0	308.0	305.2±9.7

(L1L): Width of the left lobe of the rete at the level of their left arterial root. (L1R): Width of the right lobe of the rete at the level of their right arterial root.(L2L): Width of the left lobe of the rete at the middle of the hypophysis.(L2R): Width of the right lobe of the rete at the middle of the hypophysis. (L3L): Width of the left lobe of the rete at the level of the proximal part of the left internal carotid artery.(L3R): Width of the right lobe of the rete at the level of the proximal part of the right internal carotid artery. (LRERin situLeft): Length of the left lobe of the rete. (LRERin situRight): Length of the right lobe of the rete. (LRER separatedLeft): Length of the left lobe of the rete after dissection and separation. (LRERseparatedRight): Length of the right lobe of the rete after dissection and separation. (∑ LRER separated): Total length of the rete.

Pictures were taken with a Sony digital camera. Terms are used in agreement with the Nomina Anatomica Veterinaria (ICVGAN, 2005). Data are presented as mean ± SD.

RESULTS

In camels, the RERM had a spongy appearance, and consisted of a dense network of anastomosing arteries occupying the entire cavity of the cavernous sinus. It is bordered laterally by the maxillary nerve and medially by the hypophysis gland. Dorsally, it was related to the piriform lobe and the pons of the encephalon. The RERM was H-shaped, and was composed of two lobes: the right and left lobes were located on each side of the hypophysis (Figs. 1, 4). The length of the left lobe of the rete was 6.0 ± 0.4 mm and the length of the right lobe was 5.8 ± 0.5 mm (Table I, Fig. 1).

Each lobe was divided into a rostral and a caudal compartments, with respect to the hypophysis. The rostral compartment represented the main part of the arterial network.

In camels, the blood affluent from the arterial network was double, with a rostral and a caudal roots. The rostral root, largely located in front of the hypophysis, was the most important because of its division into multiple anastomosing branches of the maxillary (7 to 14) and the ophthalmic arteries (2 to 3). The caudal root was only the proximal part of a large internal carotid artery.

Both roots split profusely before reaching the cavernous sinus, which gives the network its spongy and elongated shape, even more elongated than the cavernous sinus itself (Figs. 3, 5).

This network generates laterally and rostrally to the hypophysis, in a dorso-lateral direction, the distal part of the internal carotid artery. Only after few

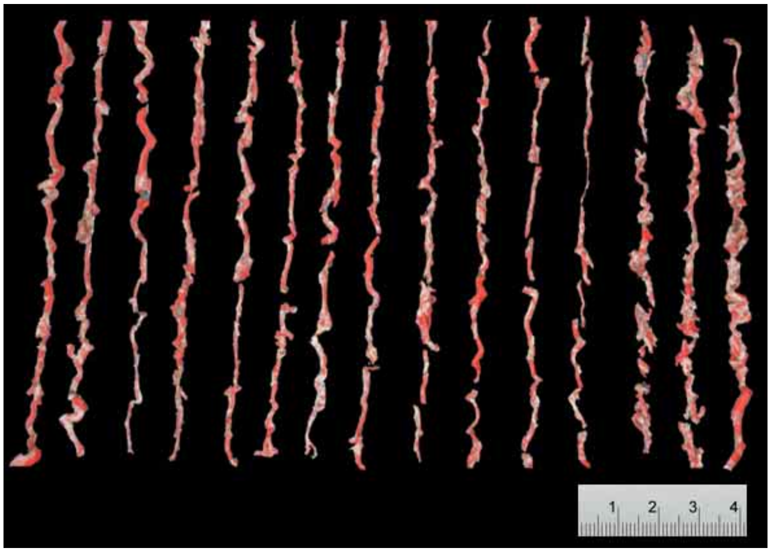

Fig. 2. Isolated arteries of a rostral lobe of the rete. The vessels were cut so as to create straight segments and the assembly was restored and measured.

millimeters, it was divided into two branches at the base of the encephalon: the rostral cerebral artery and the communicating caudal artery, that formed the arterial circle of the base of the encephalon, previously called circle of Willis.

The width of the lobes was superior rostrally and at the level of the hypophisis (Table I, Fig. 1). The average width of the rostral root rostral emerging from the maxillary and external ophthalmic arteries was 13.3 mm for the left lobe (L1L) and 11.0 mm for the right lobe (L1R). Next to the middle of the hypophysis, the corresponding average width for the network was 20.3 mm for the left lobe (L2L) and 21.0 mm for the right lobe (L2R). This width that reduces next to the caudal root to 4.1 mm for the left lobe (L3L) and to 4.3

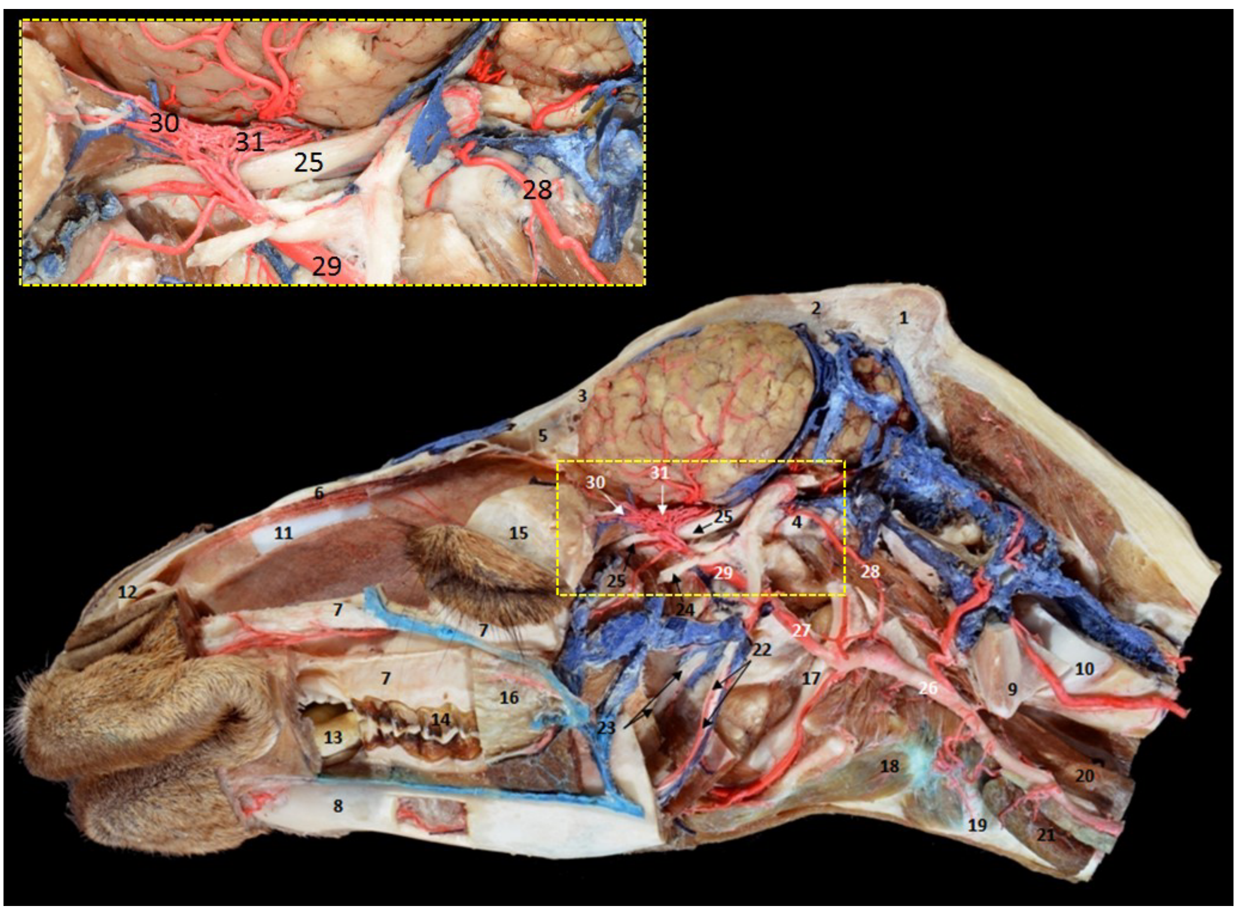

Fig. 3. Arteries of the head of the dromedary camel withrostral epidural rete mirabile in situ. 1:Occipital bone; 2:Parietal bone; 3:Frontal bone; 4: Sphenoid bone; 5: Frontal sinus; 6:Nasal bone; 7:Maxillary bone; 8: Mandible; 9:Atlas; 10:Axis;11:Nasal septum; 12:Nasal cartilage; 13: Tongue; 14: Premolar dens; 15: Eyeball and lacrimal gland; 16:Buccal salivary glands; 17: Hyoid apparatus;18:Larynx; 19: Trachea; 20:Esophagus; 21:Thyroid gland; 22: Mandibular nerve; 23: Lingual nerve; 24:Buccal nerve; 25: Maxillary nerve; 26:Common carotid artery; 27: External carotid artery; 28: Proximal part of the internal carotid artery; 29:Maxillary artery; 30:Rostral epidural rete, root of ophthalmic artery; 31:Rostral epidural rete.

mm for the right lobe (L3R). The average length of each lobe, taken between the rostral and the caudal roots, was 6.0 cm for the left lobe and 5.9 cm in the right lobe. After spreading and reconstructing the arterial network in straight segments, the average length was 155.6 cm for the left lobe and 149.6 cm for the right lobe. The average length of the arterial network of the five heads of this study was to 305.2 cm (Table I).

Cross sections through different parts of the RERM network show that in camels, the arterial network was bipolar. Only very fine arteries existed between the rostral and the caudal roots of the RERM, and all showed a narrow diameter.They were strongly intricate, which gaves the specific spongy appearance of the network. The density of these arteries was 33 arteries at the rostral root, 56 facing the medium of the hypophysis and 21 at the posterior root (Fig. 4).

Small venules, strongly entangled in the meshes of the RERM, constitute the cavernous venous system, and form an effective web, satellite of the epidural network.

Finally, the combined length of the RERM after separation of the arteries was 305.2 ± 9.7 cm.

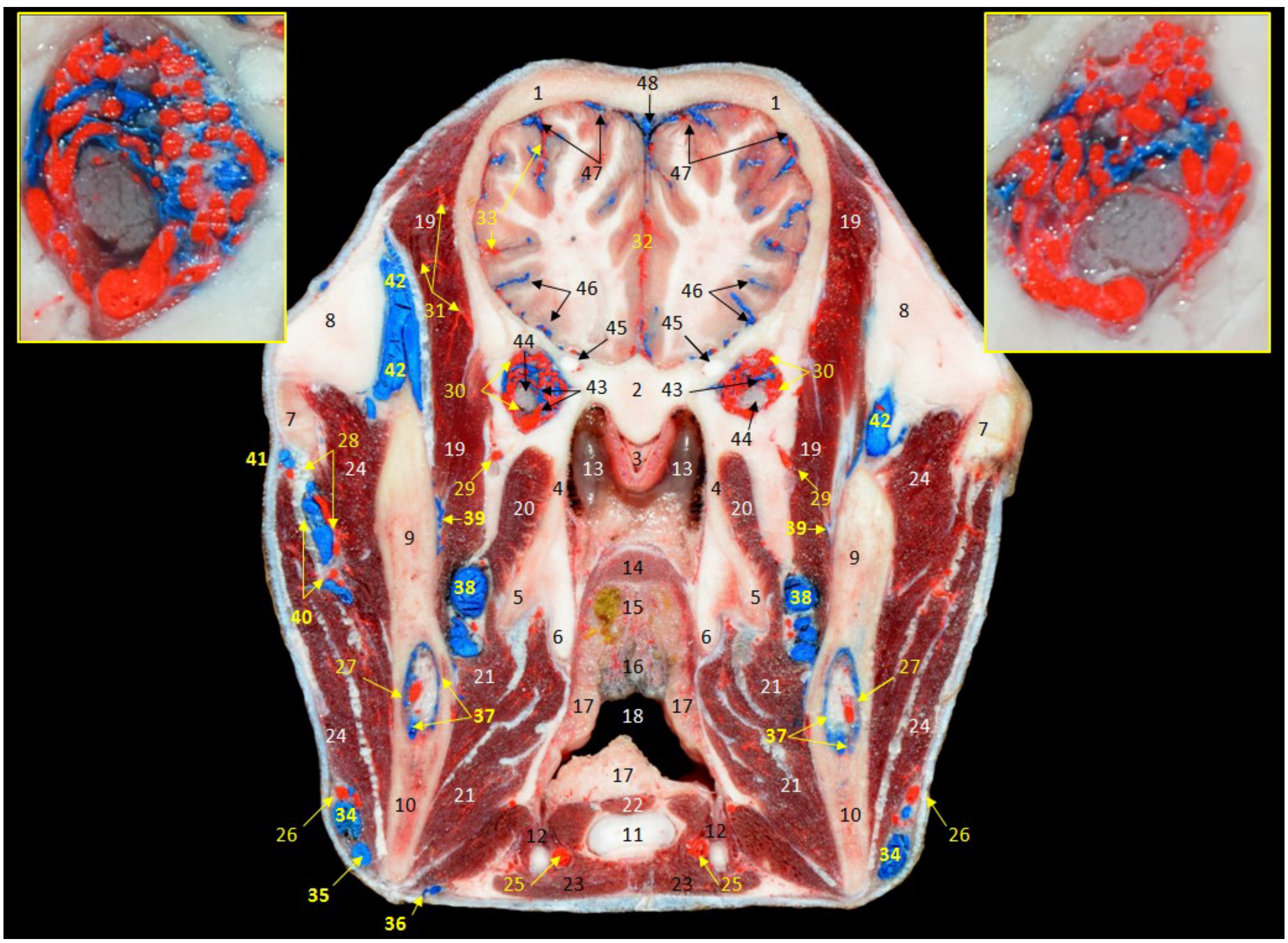

Fig. 4. Cross section of camel's head through the epidural rostral rete in the rostral root. 1:Parietal bone; 2:Sphenoid bone; 3: Vomer; 4:Perpendicular plate of the palatine bone; 5: Pterygoid process of the sphenoid bone; 6: Pterygoideus process; 7: Zygomatic bone; 8:Orbitofrontal temporal fat pad; 9:Branch of the mandible; 10: Angle of the mandible; 11:Body of the hyoid bone; 12:Thyroid-hyoideum (horn of the hyoid bone); 13:Nasopharynx (rostral part); 14: Atlantoaxial pharyngien muscle; 15: Soft palate; 16: Diverticulum of the soft palate; 17: Palatal glands; 18:Oropharynx; 19:Temporal muscle; 20: Lateral pterygoid muscle; 21: Medial pterygoid muscle; 22: Hyoepiglottic muscle; 23:Omohyoid and thyroid muscles; 24:Masseter muscle; 25:Lingual artery; 26: Facial artery; 27: Mandibular alveolar artery; 28:Transverse artery of the face; 29:Infraorbital artery; 30:Rostral root of the epidural rostral rete; 31: Muscular branches of the deep temporal artery; 32:Anastomosis of rostral cerebral arteries; 33: Parietal branch of the middle cerebral artery; 34: Facial vein; 35: Superficial vein of lower lip; 36:Submental vein; 37: Mandibular alveolar vein; 38: Maxillary vein; 39: Pterygoid veins; 40: Masseteric vein; 41: Transverse vein of the face; 42:Deep temporal vein (rostral); 43: Cavernous sinus; 44: Maxillary nerve; 45: Optic nerve; 46:Ventral cerebral veins; 47:Dorsal cerebral veins; 48:Dorsal sagittal sinus.

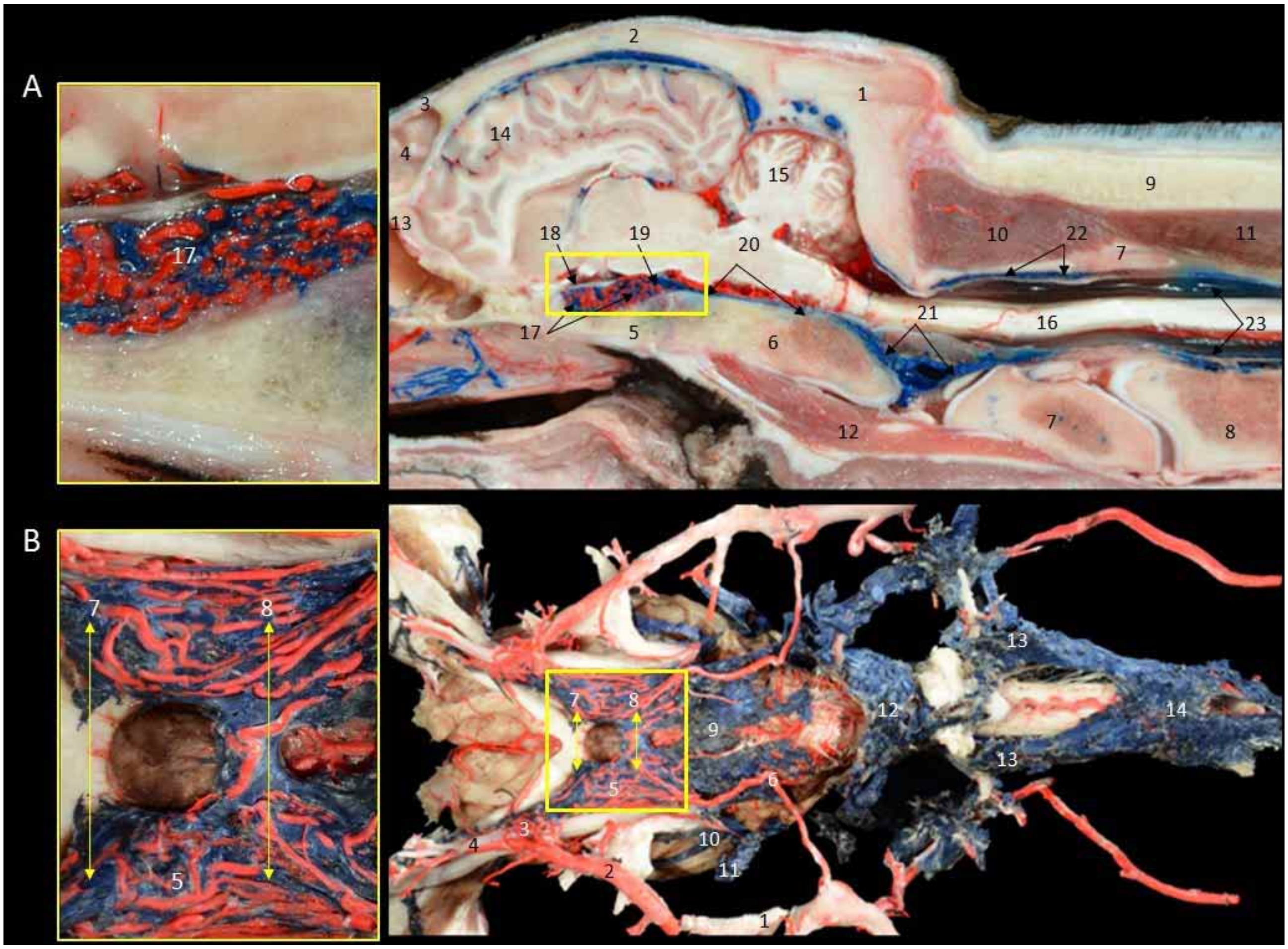

Fig. 5. Epidural rostral rete and cavernous venous system of the dromedary camel. A. Sagittal sectionof the head at 1 cm from the median plane. 1: Occipital bone; 2: Parietal bone; 3: Frontal bone; 4: Frontal sinus; 5: Sphenoid bone; 6:Occipital bone; 7:Atlas; 8: Axis; 9: Nuchal ligament; 10: Dorsal rectus muscle of the head, 11: Semispinalis capitis muscle; 12: Ventral rectus muscle and long muscle of the head; 13: Olfactory lobe; 14: Left cerebral hemisphere; 15:Cerebellum; 16: Spinal cord; 17: Epidural rostral rete, rostral part; 18:Rostral cavernous sinus; 19: Caudal cavernous sinus; 20: Ventral petrosal sinus; 21: Basilar venous plexus; 22:Occiput atloïdien venous plexus; 23:Internal vertebral venous plexus. B. Ventral view of the encephalon of the dromedary camel with the arterial and venous vascular tributaries. 1: External carotid artery; 2: Maxillary artery; 3: Rostral root of the epidural rostral rete; 4:External ophthalmic artery; 5: Epidural rostral rete; 6: Internal carotid artery; 7: Rostral cavernous sinus; 8: Caudal cavernous sinus; 9:Ventral petrosal sinus; 10: Petrosal sinus; 11: Sinus and temporal emissary vein of retro-articular foramen; 12, 13:Occiput atloïdien venous plexus. 14: Internal vertebral venous plexus.

DISCUSSION

This is a description of some quantitative aspects of the RERM of the dromedary camel, complementary to the works of Ocal *et al*. (1998, 1999) that only showed data about diameters of arteries, but nothing related to their length.

In camels, the H-shape is closely comparable to the RERM of the cow, as described in the works of Steven (1964) and Wang *et al*. It is different from the U-shape of the yak, a large species of wild Himalayan cattle with a long fleece, studied by Wang *et al*. However, the RERM of the camel extends far rostrally than the pituitary gland, because of its double root.

In the yak and the cow, blood affluents of each lobe of the RERM are composed mainly by anterior anastomotic branches from the maxillary and the external ophthalmic arteries, which compose the rostral root of this network. Rostrally to the hypophysis, the root was composed of 6.73

and 5.22 branches. In both species, a single posterior anastomotic branch emerges from the maxillary artery, next to the middle of the pituitary gland and ends in the RERM. Meanwhile, the posterior root of the arterial network is reduced to the proximal part of the internal carotid artery. This posterior root is vestigial and has a small diameter, about 0.50 mm (Wang *et al*.).

Some authors even mention the existence of arteriovenous anastomoses within the RERM (Zguigal & Ghoshal, 1991b). We need more studies of these anastomoses and their rol.

The measures reported in this study as the length of RERM after separation of 305.2 ± 9.7 cm were indicative of the importance of this arterial disposition for the regulation of blood pressure to the encephalon with the thermoregulatory function.

To conclude, we added information to literature in relation to morphometry of the camel RERM and showed this interesting structure with photographic documentation of dissections with latex injection in arterial and venous vessels.

JERBI, H.; KHALDI, S. & PÉREZ, W. Estudio morfométrico de la rete mirabile epidural rostral en el dromedario (*Camelus dromedarius*, Linnaeus 1758). *Int. J. Morphol., 34(4)*:1429-1435, 2016.

RESUMEN: En los camellos, la rete mirabile epidural rostral (RMER) tenía una apariencia esponjosa y consistía en una densa red de arterias anastomosadas que ocupaban toda la cavidad del seno cavernoso. En este estudio se midió la longitud de cada lóbulo epitelial rostral de la rete mirabile, tomado entre las raíces rostral y caudal, disecadas *in situ*, antes de su propagación y después de la reconstitución, como así también la longitud total de la rete mirabile epidural rostral tras la reconstitución lineal. La longitud del lóbulo izquierdo de la rete mirabile fue de 6,0±0,4 mm y la longitud del lóbulo derecho fue de 5,8±0,5 mm. La longitud combinada del RMER después de la separación de las arterias fue de 305,2±9,7 cm. Para concluir, se agregó información de la literatura en relación con la morfometría del RMER de camellos y se mostró esta interesante estructura con documentación fotográfica de disecciones con inyección de látex en vasos arteriales y venosos.

PALABRAS CLAVE: Anatomía; Arterias; Cerebro; Camello; Encéfalo; Sistema vascular.

REFERENCES

Elkhawad, A. O. Selective brain cooling in desert animals: the camel (*Camelus dromedarius*). *Comp. Biochem. Physiol. Comp. Physiol., 101(2)*:195-201, 1992.

Kanan, C. V. The cerebral arteries of *Camelus dromedarius*. *Acta Anat. (Basel), 77(4)*:605-16, 1970.

Khamas, W. A. & Ghoshal, N. G. Gross and scanning electron microscopy of the carotid rete--cavernous sinus complex of the sheep (Ovis aries). *Anat. Anz., 159(1-5)*:173-9, 1985.

Kieltyka-Kurc, A.; Frackowiak, H.; Zdun, M.; Nabzdyk, M.; Kowalczyk, K. & Tokacz, M. The arteries on the base of the brain in the camelids (*Camelidae*). *Ital. J. Zool., 81(2)*:215-20, 2014.

Mitchell, D.; Maloney, S. K.; Jessen, C.; Laburn, H. P.; Kamerman, P. R.; Mitchell, G. & Fuller, A. Adaptive heterothermy and selective brain cooling in arid-zone mammals. *Comp. Biochem. Physiol. B Biochem. Mol. Biol., 131(4)*:571-85, 2002.

Mitchell, G. & Lust, A. The carotid rete and artiodactyl success. *Biol. Lett., 4(4)*:415-8, 2008.

International Committee on Veterinary Gross Anatomical Nomenclature (ICVGAN). *Nomina Anatomica Veterinaria.* 5th ed. Knoxville, Editorial Committee Hannover, Columbia, Gent, Sapporo, 2005.

Ocal, M. K. & Aslan, K. A quantitative study on the retial arteries in the bovine fetus. *Ann. Anat., 176(2)*:151-3, 1994.

Ocal, M. K.; Erden, H.; Ogut, I. & Kara, M. E. A quantitative study on the retial arteries in one-humped camels. *Ann. Anat., 180(4)*:369-71, 1998.

Ocal, M. K.; Erden, H.; Ogut, I. & Kara, M. E. A quantitative study of the circulus arteriosus cerebri of the camel (*Camelus dromedarius*). *Anat. Histol. Embryol., 28(5-6)*:271-2, 1999.

Steven, D. H. The distribution of external and internal ophthalmic arteries in the ox. *J. Anat., 98*:429-35, 1964.

Uehara, M.; Kudo, N. & Sugimura, M. Morphological studies on the rete mirabile epidurale in the calf. *Jpn. J. Vet. Res., 26(1-2)*:11-8, 1978.

Wang, X. R.; Liu. Y.; Zhang, L. P.; Wang, X. J. & Wu, J. P. Comparative anatomical study of the epidural retia mirabile in the yak and cattle. *Asian J. Anim. Vet. Adv., 7(9)*:884-90, 2012.

Wang, W. H. The carotid rete of the camel (*Bactrianus camelus*). *Chin. J. Anim. Vet. Sci., 20(1)*:90-5, 1989.

Zguigal, H. & Ghoshal, N. G. Dural sinuses in the camel and their extracranial venous connections. *Anat. Histol. Embryol., 20(3)*:253-60, 1991a.

Zguigal, H. & Ghoshal, N. G. Gross and histologic study of the rostral epidural rete mirabile and the cavernous sinus in one-humped camels. *Am. J. Vet. Res., 52(7)*:1173-7, 1991b.

Correspondence to:
Dr. Hassen Jerbi
Service d'Anatomie
Ecole Véterinaire Sidi Thabet
CP 2020
TUNISIE

Email: hassen_jerbi@yahoo.fr

Received: 27-02-2016
Accepted: 02-09-2016