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ANATOMICAL STUDY OF THE INTERNAL CAROTID ARTERY OF THE AULACODE (Thryonomys swindérianus, TEMMINCK 1827)

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ABSTRACT

The arterial circle at the base of the skull appears to be supplied only by the vertebrobasilar system. The anatomy of the internal carotid artery is not known. The aim of this study was to contribute to a better understanding of the anatomy of the arterial system of the aulacode. A total of twelve (12) carotid arteries from six (6) grasscutters were injected with neoprene latex to study the origin, path, termination, collateral branches and brain irrigation areas of the. internal carotid artery. Originating from the common carotid artery, the internal carotid arteries, right and left, flowed forward and out to reach the lateral surfaces of the trachea. In the cervical region, they emitted three collateral branches, the posterior laryngeal artery, the artery of the neck muscles, and the encephalic artery. These different arteries supplied the larynx, neck and brain, respectively. The encephalic arteries were either single or double. The arteries of the neck muscles were dividing at their endings or not. The observation of the latex in the brain reflects the participation of the internal carotid artery in the vascularization of the brain, or at least of anastomoses between its branches and those of the external carotid artery or the vertebro-basilar system.

Key words: Rodent, Thryonomydae, brain, vascularization.
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INTRODUCTION

The grasscutter (Thryonomys swinderianus), is a wild African rodent, of the thryonomidae family, found in grassy savanna, clearings, and wet or marshy areas of Africa. However, it can be domesticated (Edderai et al., 2001).

In different fields, it constitutes the research subject of several African university teams, with the aim of making it a laboratory animal model (Broalet et al., 2014). Thus, taking into account the variant of its encephalic vascularization, Broalet (2014) revealed that it is possible to use this animal, as an experimental laboratory model in our universities. It is with this in mind that James (2016) studied the anatomy of the grasscutter carotid system in cardiovascular disease. He limited himself to the external carotid artery without being able to specify what becomes of the internal carotid artery. The cardiovascular system, in particular the encephalic system, is important to know when considering pathology or toxicology experiments.

According to some authors (Tandler, 1898; De Vriesse, 1905; Araùjo, 2005) the internal carotid artery (ICA) undergoes an obliteration on its way to the base of the brain giving a fibrous cord respectively in the squirrel (Sciurus vulgaris), the Murmeltier (Arctomy marmota), the chinchilla (Chinchilla lanigera), and in the guinea pig (cavia cobaya), which have a type of encephalic vascularization close to the grasscutter. No studies were found in our literature searches on the anatomy of the carotid artery of the grasscutter.

The general objective of this work was to contribute to a better understanding of the anatomy of the carotid arterial system of the grasscutter.

MATERIALS AND METHODS

This study was carried out on a series of six (6) adult grasscutters (4 males and 2 females) aged at least five (5) months. All the animals were from domestic breeding. For each animal, after general anesthesia with Calmivet® (Acepromazine) (1ml for 10 kg of body weight), and with Ketamine® (Imalgene ND) (2ml for 5kg of body weight). A sternotomy was performed, exposing the heart and other intrathoracic organs. Each animal was rapidly exsanguinated with a puncture of the left ventricle using a trocar connected to a syringe. The vascular system was then washed with a cold 0.9 ‰ saline solution mixed with 5000IU of heparin, then an injection of 10cc of liquid ammonia was carried out at the end of the washing.

The subclavian arteries, right and left, were ligated to prevent latex from entering the right and left vertebral arteries. Then, a manual pressure injection using a large 15 cc syringe of a solution of Latex Neoprene stained by its red pigment was made into the left ventricle through the trocar.

The craniospinal block of each animal was taken together with the intrathoracic organs and the anterior cervical region. The whole was immersed in a 10% dilute Formaldehyde solution for 72 hours.

A fine dissection performed exposed the aortic arch and the departure of the supra- aortic vessels. The two carotid arteries or their common trunk as well as their subdivision branches were then identified. The internal carotid arteries were dissected until they entered the skull. A craniectomy made it possible to remove the brain which was stored in formalin diluted at 10% for three days, finally to demonstrate the superficial vascularization of the brain.

RESULTS

Origin of the internal carotid artery

The ICA arises from the bifurcation of the common carotid artery at the upper edge of the thyroid cartilage at the angle of the jaw. (Figure 1). Indeed, the two common carotid arteries located on either side of the trachea each divided at the level of the carotid bifurcation, about 4 centimeters on average from the common carotid trunk, to form the ICA and the external carotid artery. . The external carotid artery continued the course of the common carotid artery on the lateral aspect of the trachea, while the ICA moved upwards towards the skull, passing under the mandible, parallel to the hypoglossal nerve.

Path of the internal carotid artery

The ICA followed a straight ascending course, then sinuous at the level of the zygomaticum bone. It walked with the hypoglossal nerve vertically in the direction of the skull, crossed the path of the recurrent laryngeal nerve to either pass under the latter (Figure 1), or, pass between it and the hypoglossal nerve, in 2 cases in the same grasscutter (Figure2). It followed the same direction as the atrial branch of the external carotid artery, and bypassed the zygomaticum bone to the base of the ear (Figure 3).

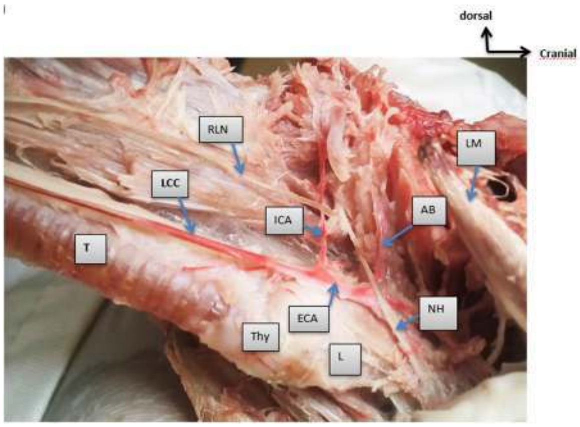

Figure 1. Origin of the internal carotid artery. LCC = left common carotid; ECA = external carotid, ICA = internal carotid artery; AB = auricular branch; RLN = recurrent laryngeal nerve; Thy = Thyroid; T = trachea; LM = left mandible; L = larynx; HN = hypoglossal nerve

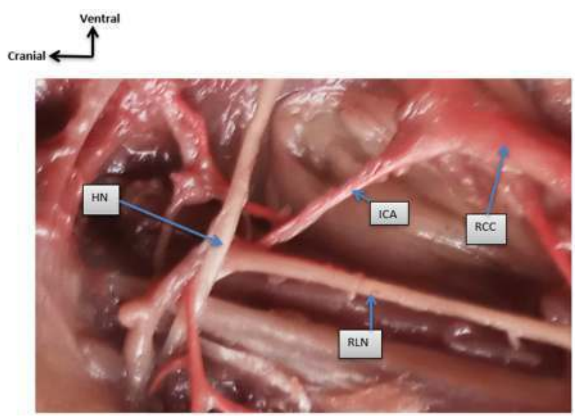

Figure 2 : path of the deviated internal carotid artery at the point of contact of the recurrent laryngeal and the hypoglossal nerves. RCC = right common carotid; ICA = Internal carotid; RLN = recurrent laryngeal nerve; HN = hypoglossal nerve

Termination

The ICA appeared to end at the base of the outer ear, behind the zygomaticum bone (Figure 3).

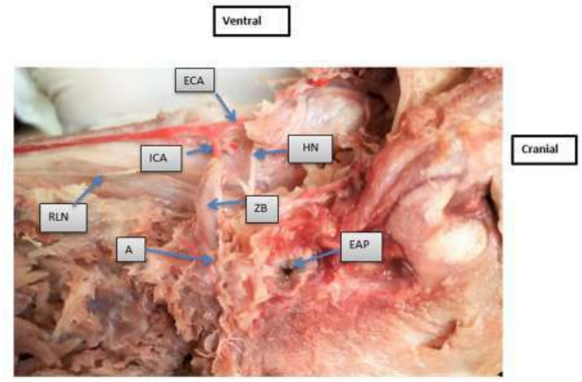

Figure 3. Lateral view of the cervical region showing the internal carotid artery at the base of the ear. ICA = internal carotid artery, ECA = external carotid artery; RLN = recurrent laryngeal nerve, HN = hypoglossal nerve; ZB = zygomaticum bone; A = prolongation of the internal carotid artery at the base of the ear; EAP = external acoustic pore.

Collateral branches (Figures 4, 5)

It emitted on its way the following main branches: the posterior laryngeal artery; the artery of the neck muscles; the encephalic artery.

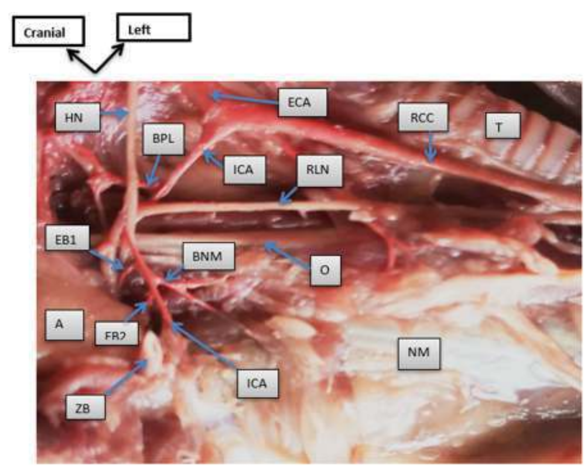

Figure 4. Internal carotid artery with its collateral branches: case where it had two encephalic branches and the case where the branch intended for the muscle of the neck was divided at its end. RCC = right common carotid, ECA = external carotid, ICA = internal carotid, RLN = recurrent laryngeal nerve, HN = hypoglossal nerve area; T = trachea; NM = neck muscle; ZB = zygomaticum bone; A = tympanic bulb area; BPL = branch of the posterior larynx; BNM = branch of the neck muscle; EB1 = first encephalic branch; EB2 = second encephalic branch; O = esophagus.

The posterior laryngeal artery was the first collateral branch of the internal carotid artery. It originated one centimeter from the origin of the internal carotid artery and ran towards the dorsal part of the larynx. The artery of the neck muscles originated one centimeter from the origin of the posterior laryngeal artery and ran towards the neck muscles. In five (05) cases the branch entered the muscle without division. This branch was less developed. In one (01) case the branch split in two at its end before entering the neck muscle. It was more developed than in the previous case. The encephalic artery separated from the anterior edge of the internal carotid artery at the same level as the branch of the neck muscles. It entered the base of the skull, into the occipital foramen, and appeared at the base of the brain.

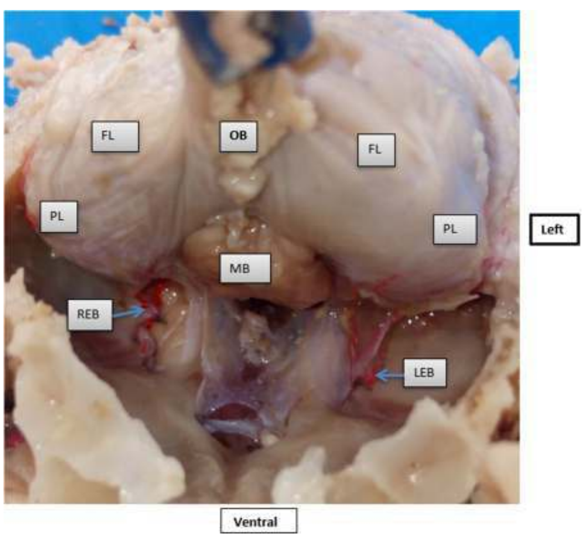

Figure 5 : Emergence of the encephalic branches of the internal carotid arteries (left and right) at the base of the brain. FL = frontal lobe; PL = Parietal lobe; OB = olfactory bulb; MB = mammillary body; REB = right encephalic branch; LEB = left encephalic branch.

The encephalic territories of the internal carotid artery

The encephalic arteries have a zone of superficial and restricted vascularization: the piriform lobe, the interhemisheric zone, the olfactory bulb.

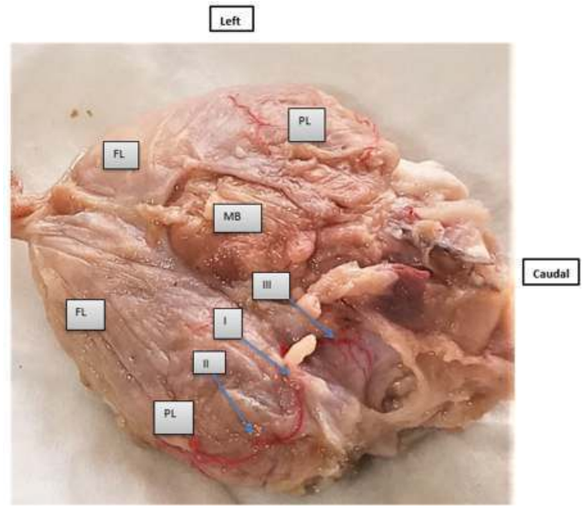

Figure 6 : ventro-lateral view of the glasscutter brain. PL = Piriform lobe; FL = frontal lobe; MB = Mamillary body; I = point of division of the encephalic branch; II = rostral branch; III = caudal branch.

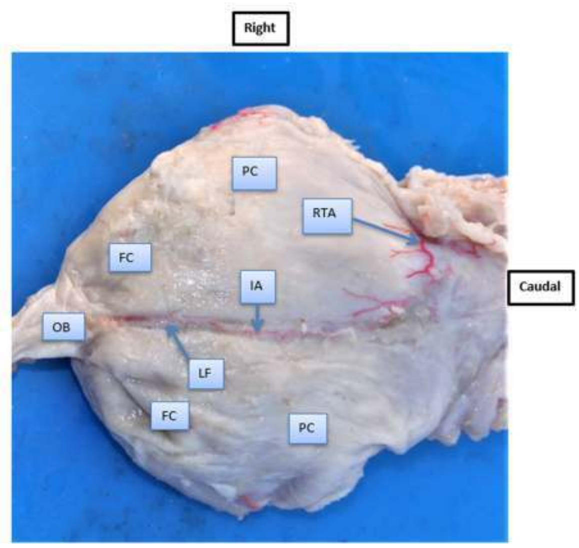

Figure 7. Dorsal view of the brain showing the interhemispheric artery and the tectal rostral artery. RTA: Rostral tectal artery; IA: Interhemispheric artery; OB: olfactory bulb; FC: frontal cortex; PC: Parietal Cortex; LF = longitudinal fissure.

When they entered the skull, the right and left encephalic branches of the internal carotid artery each divided into two branches at the level of the piriform lobes: a caudal and a rostral one. the caudal branches vascularized the pear-shaped lobes; the rostral branches followed the route of the encephalic artery in the longitudinal fissure to the olfactory bulb.

When they entered the skull, the right and left encephalic branches of the internal carotid artery ascended on the piriform lobes and each divided into 2 branches, rostral and caudal (Figure 6). On each side, the caudal branches supply the piriform lobes. The rostral branches followed the route of the encephalic artery in the longitudinal fissure to the olfactory bulb (Figure 7)

The brain vascularization by the ICA was restricted and superficial in all observed cases. It concerned the piriform lobe, the inter-hemispherical space, the olfactory bulb.

DISCUSSION

The ICA of the grasscutter (Thryonomys swinderianus, Temminck 1827) has never been studied. The hypothesis that the ICA would undergo obliteration on its way to the base of the brain and not participate in the cerebral vascularization inspired this study. Thus, the study of ICA from its origin to its termination was a fundamental step in understanding the descriptive anatomy of the grasscutter carotid arterial system and its application in basic research.

To do this, we chose the classic method of studying vessels in anatomy, the dissection after injection with latex. This method consisted of injecting a mixture of latex and dye-stuff into a well-cleaned vascular bed beforehand and following the path of the vessels by dissection. Passing through a 10% diluted formaldehyde bath, recommended by the majority of authors (Esteves, 2013; Araùjo, 2005; de Souza, 2013), by inducing rigidity of the vascular wall, allowed a good anatomical analysis.

The common carotid arteries, left and right, divided into the internal carotid artery and continued their paths into the external carotid artery. This disposition has been found in the Chinchilla (Chinchilla lanigera) (Araùjo, 2005), in the capybara (Hydrochoerus hydrochaeris) (Reckziegel, 2001). ICA was extremely thin and of small caliber, similar to that of the guinea pig (Shively and Stump; 1974). In its course, the ICA of the grasscutter crossed the recurrent laryngeal nerve and passed with the hypoglossal nerve. This type of trajectory was also observed by Araùjo (2005) in chinchilla (lanigera). According to Jablonski and Brudnicki (1984) and Roskosz (1988), the internal carotid arteries of chinchillas run from the surface of the brain base to the optic nerve, anastomosing with the left and right terminal branches of the basilar artery, and divide these branches into two segments. These findings are different from our observations. Audoin (1827), had noted that the ICA seemed to be lacking at the level of the arterial circle of the base but was found intracranially in hibernating animals and in rodents. The ICA enters the skull through the jugular foramen in the porcupine (Hystrix) or in the oval foramen in the cavia cobaya (Dasyprocta aguti). According to Tandler (1898), and much later Steele (2006), the ICA would undergo in the capyrabara (Hydrochoerus hydrochoerus), an obliteration on its way to the base of the brain, between the 6th and the 12th month of life. Which would logically transform it into a simple thin bead.

However, after ligation of the subclavian arteries (right and left), observation of the latex in the brain reveals the participation of ICA to the vascularization of the grasscutter encephalon. This is consistent with the observations of Araujo et al. (2005, 2007) in chinchilla (Chinchilla lanigera). According to them, in 3,3% of cases, the ICA would join the basilar artery at the level of the medulla oblongata and would contributes to the entire irrigation of the brain.

CONCLUSION

The internal carotid artery, arises from the common carotid artery, has a vertical and ascending course towards the skull, and emits three collateral branches in the cervical region; the artery of the posterior larynx; the artery of the neck muscles and the encephalic artery. Through the latter, the vascularization of the brain is in part via the internal carotid artery. An anatomical study by serial sections and / or an angiographic study would provide more precision on the brain vascularization of the grasscutter via the internal carotid artery.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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