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Contribution to the Study of Aortic Mural Structure of Opossum (*Didelphis albiventris*)

Contribución al Estudio de la Estructura Mural de la Aorta del Zorrillo (*Didelphis albiventris*)

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MARTINS M. R. F. B.; PINTO E SILVA, C. J. R. & MARTINS, B. B. Contribution to the study of aortic mural structure of opossum (*Didelphis albiventris*). ***Int. J. Morphol., 28(1)***:277-282, 2010.

SUMMARY: Opossum is considered one of the most primitive mammals, with transition evolutive characteristics. In mammals, the aorta artery is referred as the main body blood vessel. The arteries wall structural organization follows a basic pattern, being contituted of three tunics: Intima, Median and Adventicial. After euthanasia, three samples of opossum had segments from the aorta artery ascendent, thoracic descending and abdominal descending portions removed, fixed in phormalin at 10% for 48 hours. Then, the material was washed in alcohol 70% several times, dehydrated in alcohois of growing concentrations, diafanized in xylol and included in “paraplast”. Cuts with 5 to 7µm of thickness were placed in histological laminae and submitted to color methods of Hematoxilin-Eosin, Masson, Mallory and Calleja Tricromics. It was observed that in the different portions ascendent, thoracic and abdominal descending of aorta, the intima tunic presents much thick, made up of a layer of smooth muscular cells and elastic fibers, forming a limiting internal elastic membrane. In the three portions studied, the median tunic was the most evident layer, constituted of colagen fibers, smooth muscular cells arranged in a circular manner and elastic fibers, showing a variation in the mural elements proportion. It was evidenced the presence of a external elastic lamina, marking the transition between the median and adventicial tunic, formed by elastic fibers condensation. The aortic adventicial tunic showed to be little organized, having in its structure predominantely colagen fibers beans with some isolated smooth muscular fibers or in small fascicules among a few elastic fibers.

KEY WORDS: Aorta; *Opossum.*

INTRODUCTION

Many species of opossum have restrict distribution, being found only in the Americas and Australia (Tyndale–Biscoe, 1973). According to Ihering (1967), the Brazilian species of opossum have few differences among themselves and because of this it is very difficult to distinguish them. In terms of great circulation, the aorta artery in mammals is referred as the main body bloody vessel, crossing the thoracic and abdominal cavity, emitting different branches or collaterals, parietals and viscerals. The arteries directed to head, neck and thoracic member originate at the aortic arch level. Yet in the thoracic cavity, the aorta emits the endothoracic arteries, represented by parietal and visceral branches. After crossing the aortic hiato of the diaphragm muscle, the aorta provides abdominal arteries, also named visceral or parietal branches.

Usually, the arteries characterize a basic pattern of structural organization, being constituted of three layers or tunics: intima, median and adventicial. The most inner vascular layer or intima tunic is made up of: internal endothelial covering, internal subendothelial layer formed by fibroelastic conjunctive tissue, and internal elastic membrane, an elastic fiber band sometimes absent in some vessels. The vascular median tunic consists of smooth muscular cells arranged in a circular way, occurring interposition among them, with a varied quantity of elastic and collagen fibers (Leeson & Leeson, 1977).

The aorta adventicial tunic is relatively thin and little organized, contains elastic and collagen fibers and smooth muscular cells. The relative structure and thickness of each vascular tunic can vary according to the type and size of the oriented vessel (Leeson & Leeson; Simionescu & Simionescu, 1981).

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In mammals, as the arteries become distant from the heart and branch off, suffer alterations in their mural and general structure with a decrease in the elastic component and progressive increase in the muscular component (Hollinshead & Rosse, 1991; Williams *et al.,* 1995).

MATERIAL AND METHOD

In the present study, it was used 5 adult opossums from Botucatu region. For the macroscopic documentation of the aorta artery, the arterial system was injected with latex neoprene diluted in water and added Suvinil hydrosoluble red pigment. After injection, the animal was kept in cold chamber at approximately 4°C during 8 hours and then fixed with phormaldehyde at 10% through immersion.

In the animals used for segments collect for histological study, after laparotomy, the thoracic and abdominal cavities were opened and the aorta was fixed through slow arterial perfusion with neutral phormalin at 10%, using the cardiac punction way through the left ventricular cavity, followed by the right atrio section to permit blood outflow and a better fixation of the artery used. After evisceration, the aorta artery was dissecated and individualized and segments of the aorta artery ascendent, thoracic and abdominal descending portions were removed, fixed in phormalin at 10%, during 48 hours. After that period, the material was processed under histological routine and colored by the methods: Hematoxilin and Eosin (HE) according to Lillie (1954), Masson Tricromic , Mallory and Calleja, according to techniques described by Ganter & Jolles (1970) and Behmer *et al.* (1976).

All the histological material was analyzed and photographically documented by using a Axiophot 2-ZEISS photomicroscopy with "Kodacolor Gold", ISO 100 (Kodak do Brasil) film.

RESULTS

Macroscopic observations. In opossums (*Didelphis albiventris*), it was analyzed the aorta portions vascular wall structure, comprising ascendent, thoracic and abdominal descending portions (Fig. 1a). The aorta crosses the thoracic and abdominal cavities and emits different collateral, parietal and visceral branches. Soon after the ascendent portion, there is the aortic arch from which the arteries directed to the head, neck and thoracic members originate. Following, still in the thoracic cavity, the thoracic aorta extends parallelally to the spine, inside the thoracic cavity, emits the endothoracic arteries represented by the parietal and visceral branches; crosses the aortic hiato in the diaphragm muscle, is named

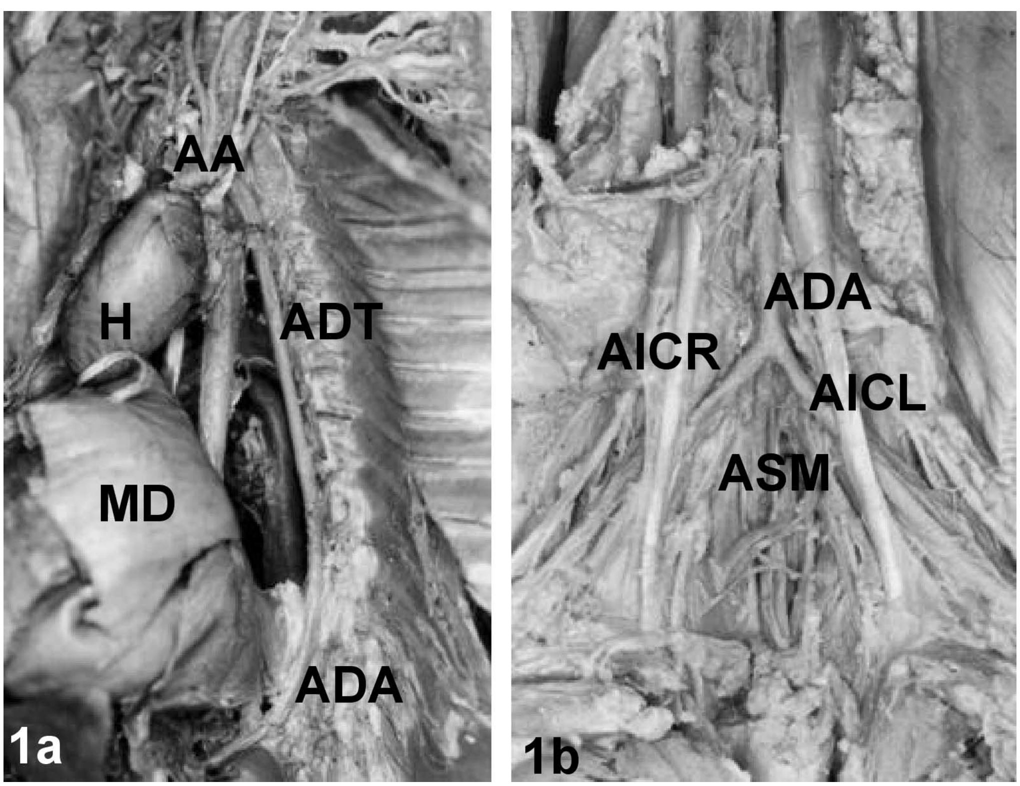

Fig. 1a. Heart (H), Ascendent aorta (AA), Descending thoracic aorta (ADT), diaphragm muscle (MD) and Abdominal descending aorta (ADA). b: Final portion of abdominal descending aorta (ADA), and terminal branches: right and left common illiac arteries (AICR, AICL) and median sacral artery (ASM).

abdominal aorta, passing along the dorsal abdominal wall, emitting paired abdominal branches, which are mainly the lombar arteries, and unpaired visceral branches that are, celiac trunk, cranial and caudal mesenteric arteries, renal, testicular and ovarian arteries. In the abdominopelvic transition the aorta finishes, emitting their terminal branches: the two common iliac arteries and the median sacral artery, destined to the pelvis and pelvic members vascularization (Fig.1b).

Segmentary structure of the ascendent, descending thoracic and abdominal aorta in opossum. In the optical microscopy analysis, it was possible to observe in the ascendent, descending thoracic and abdominal portions of the aorta of opossum that the intima tunic was formed by three different subdivisions: the endothelium, the subendothelial laminae and the internal elastic membrane. The endothelium, which covers internally the vessel, presented to be constituted of smooth muscular cells whose prominent nuclei could project to its light, while its marginal cytoplasm was difficult to be distinguished with optical microscopy (Figs. 2a and b). Such cellular layer is a constant characteristic of all blood vessels and heart and was much thick. Following this layer, there is a delicate subendothelial stratus constituted by loose conjunctive tissue. The internal elastic laminae is made up of an elastic fibers condensation, easily visible in colorations done with Calleja, (Figs. 4a, b and c), and like a pink bright ondular line in colorations done with Heatoxilin and Eosin. Such ondulation is due to a pressure fall inside the vessel after death, not keeping the wall distended.

The median tunic is formed by a mixture of smooth muscular cells, collagen fibers, elastic fibers and fibroblasts. Thus, in the three portions studied, this tunic showed to be the most evident layer constituted of the elements above. The smooth muscular cells are displaced in a circular arrangement around the light. It was observed a progressive increase in the muscular component of this tunic from the segment of the ascendent, descending thoracic and abdominal aorta (Figs. 3a and b); while the elastic component remained balanced in the ascendent and descending thoracic segments; revealing a discreet decrease of this component in the abdominal descending aorta segment (Figs. 4a, b and c). In spite of the elastic fibers displacement, it was noticed that they were arranged in a concentric way along the whole thickness of the vessel wall median tunic, meaning that they had the same distribution pattern either next to the internal elastic laminae or the adventicial tunic (Figs. 4a, b and c). Sometimes, it was possible to observe the presence of elastic fibers trabecules that formed a joint bridge among the lamellae (Fig. 4b).

The external elastic laminae constituted of elastic fibers condensation was much evident between the median and adventicial tunics of all aortic segments studied (Fig. 4c).

The adventicial tunic of the ascendent, descending thoracic and descending abdominal aorta formed by conjunctive tissue showed to be little organized, having in its structure in a predominant way collagen fibers, some smooth muscular fibers, isolated or in small groups, among a few elastic fibers (Figs. 2a, 3a, and 4b).

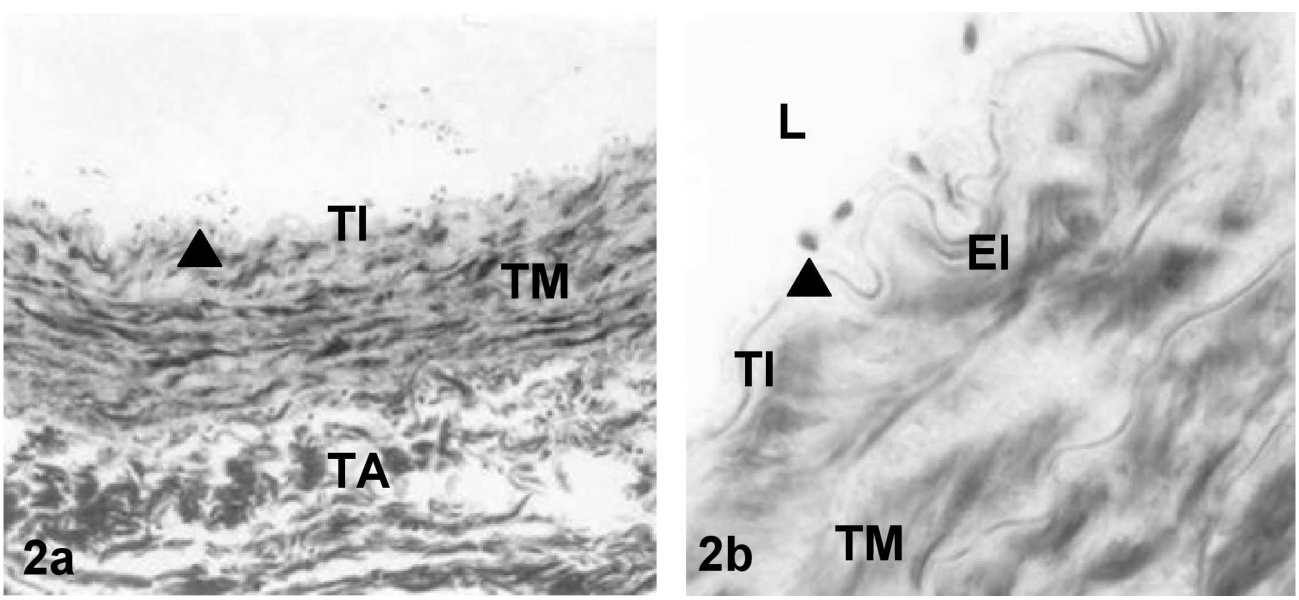

Fig. 2a. Photomicrography of ascendent aorta in opossum. Mallory tricromic, 20X. b: Photomicrography of descending thoracic aorta in opossum. Mallory tricromic, 100X. Intima tunic (TI), smooth muscular cells that form the intima tunic endothelium (s),Vascular light (L), Internal elastic laminae (EI), Median tunic (TM) and Adventicial tunic (TA).

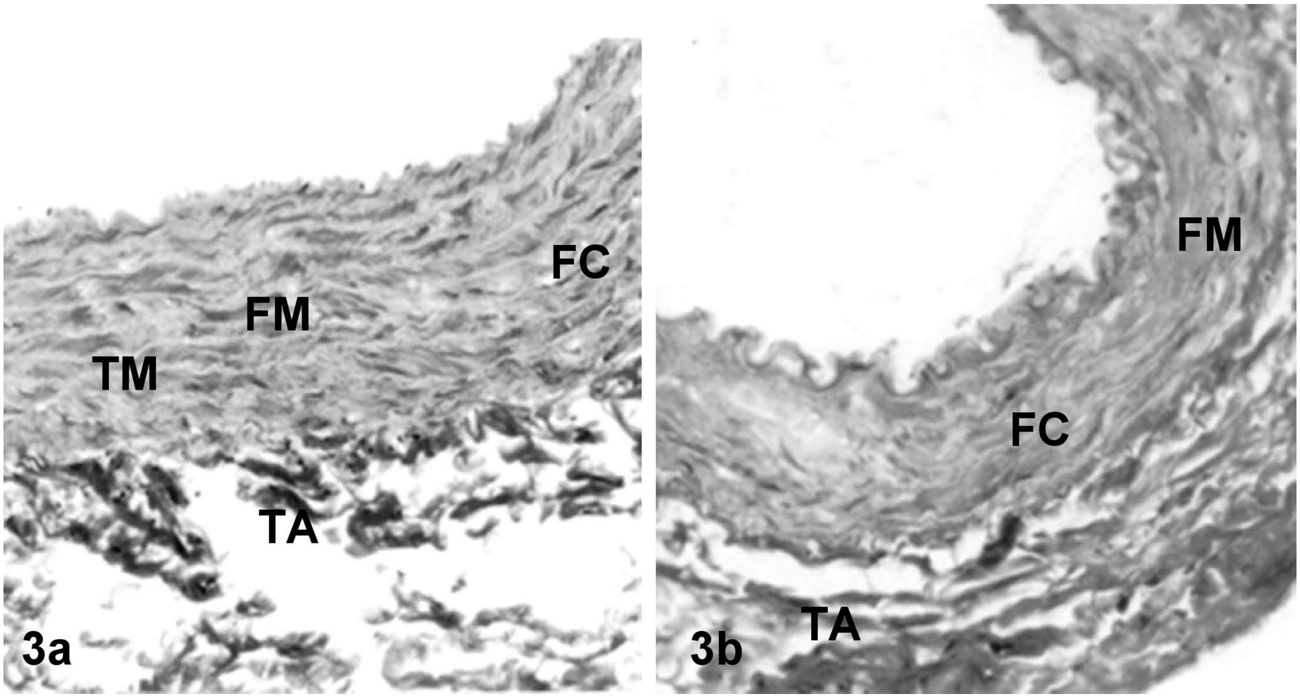

Fig. 3. Photomicrography in a: descending thoracic aorta, in b: abdominal descending aorta in opossum. Masson Tricromic, 20X. Muscular fibers (FM), collagen fibers (FC) of the Median Tunic (TM), and Adventicial Tunic (TA).

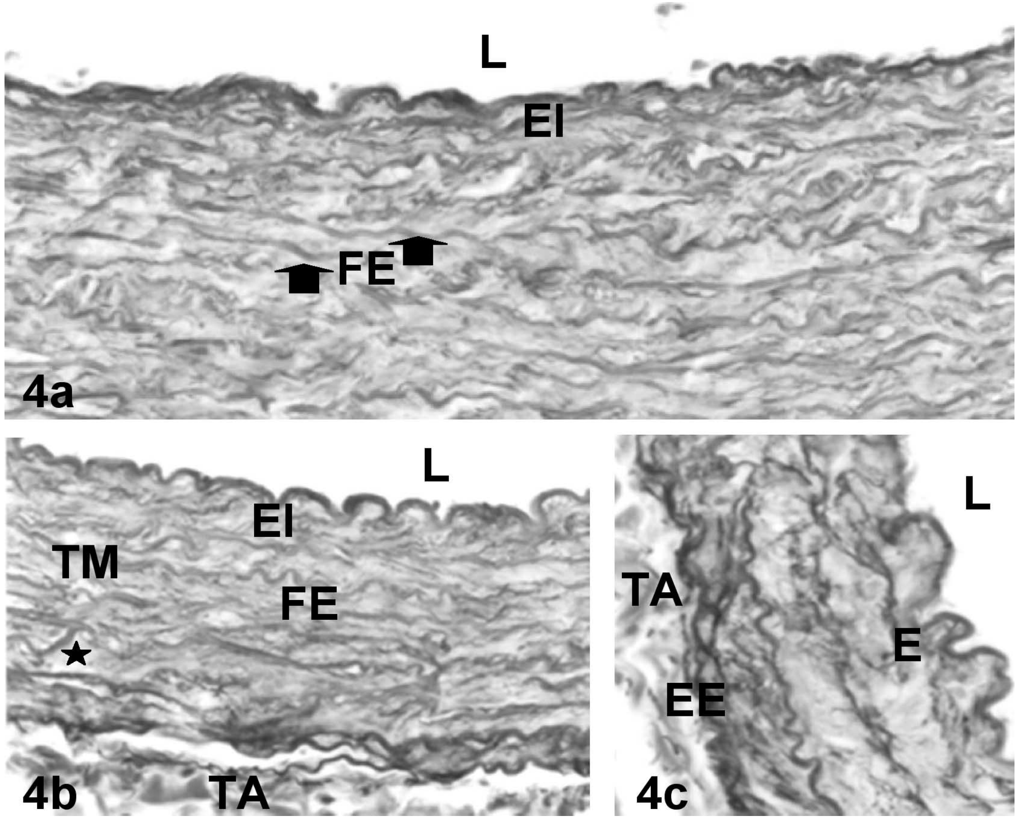

Fig. 4. Photomicrography of the ascendent aorta. a: descending thoracic aorta; b: and abdominal descending aorta; c: of opossum. Calleja, 40X. Vascular light (L), internal elastic laminae (EI), elastic fibers (FE) of the Median Tunic (TM), elastic trabecules (*),external elastic laminae (EE) and Adventicial Tunic (TA).

DISCUSSION

According to specialized textbooks, the aorta is considered a conducer vessel of great diameter that transports blood to vessels of smaller diameter of the blood vascular system in the systemic circulation. The aorta is an elastic-type vessel due to its structural richness in elastic fibers. These elastic tissue elements are highly developed and distributed in the whole aortic wall, forming a firm and retractable wall (Snell, 1985; Evans, 1993).

In a general way, the three arteries layers present different thickness in accordance with the vascular region studied, as well the type of tissue that comprises the vascular wall layers is variable, depending on the artery classification, that is, if the artery is elastic, muscular or arteriole (Ham & Cormack, 1983).

The intima tunic of the ascendent, descending thoracic and abdominal portions of the opossum aorta is very thick and made up of circular elastic fibers that constitute an evident internal elastic laminae. Similar data were described by Dubreuil & Lacoste (1931) for great diameter arteries in human, Mello (1999) for the three portions of the aorta and external iliac artery in guinea pig, rat and chicken. On the other hand, as for the aorta internal elastic laminae, our observations, as previously described, are contrary to those by Leeson & Leeson, Simionescu & Simionescu, Snell, Williams et al., who state that the internal elastic laminae of human great arteries are not evident or, sometimes, are absent.

Moss & Benditt (1970), Berry *et al.* (1974) and King & McLelland (1981) in their works with birds, state the non-existence of an internal elastic laminae.

The median tunic is the thickest one, being so the most evident and the most variable in terms of composition, as observed in our results. At light microscopy, the ascendent, descending thoracic and abdominal portions of aorta in opossum presented in the median tunic high quantity of elastic fibers, forming evident elastic lamelae displaced, mainly, in a circular way intimally through trabecules and elastic fibers. Structure similar to this one was also evidenced by Di Fiore (1960); Simionescu & Simionescu and Snell, for great diameter arteries in some mammals, including human.

Simionescu & Simionescu described that the mural elastic fibers orientation in great elastic arteries is in different directions, aiming at balacing the mechanical “displacement” in the vascular wall. However, the elastic fibers displacement in the aortic median tunic in the opossum studied by us had an organized pattern, where the elastic laminae were displaced in the same equitative way, along the whole median tunic thickness.

Yet, as for the behavior of elastic lamella, Mello observed that in the aorta ascendent and descending thoracic of chickens, they presented different displacement along the median tunic, being more interwoven next to the adventicial tunic and displaced longitudinally next to the intima tunic. Similar observations were corroborated by Dubreuil & Lacoste, for the human arteries walls.

The median tunic of the aorta ascendent and descending thoracic portions presented a discreet increase in elastic laminae quantity when compared to the abdominal descending portion, probably due to the increase in pulse or arterial pressure. The adventicial tunic of the aorta ascendent, descending thoracic and abdominal portions in opossum showed to be constituted predominately of collagen fibers through few smooth muscular cells and elastic fibers. This tunic is poorly organized, sometimes mixed with adjascent tissues. Similar description was made by Robertson & Khairallah (1973), Simionescu & Simionescu and Mello.

In textbooks, we could observe that some authors such as Dubreuil & Lacoste, Leeson & Leeson and Williams et al. who worked with great elastic arteries in human, agree with our results concerning to the adventicial tunic description. On the other hand, Costacurta (1969) disagrees with our results and those of the authors above by stating that the great arteries adventicial tunic is constituted predominately of higher quantity of elastic fibers than collagen fibers.

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RESUMEN: El zorrillo es considerado uno de los mamíferos más primitivos, con transición de características evolutivas. En los mamíferos, la arteria aorta se refiere como el principal vaso sanguíneo del cuerpo. La organización estructural de la pared de las arterias sigue un patrón básico, siendo contituida por tres túnicas: íntima, media y adventicial. Después de la eutanasia, tres muestras de zorrillos fueron seccionadas desde las porciones de la arteria aorta ascendente, descendente torácica y abdominal descendente, removidas, y fijadas en formalina al 10% durante 48 horas. Luego, el material se lavó varias veces en el alcohol al 70%, deshidratados en alcoholes en concentraciones crecientes, diafanizadas en xilol y se incluyeron en paraplast. Cortes de 5 a 7 mm de espesor fueron colocados en láminas histológicas y sometidas a los métodos de tinción de

Hematoxilina-Eosina, Masson, Mallory y tricrómico de Calleja. Se observó que en las diferentes porciones ascendente, torácica y abdominal descendente de la aorta, la túnica íntima se presentó mucho más gruesa, formada por una capa de células musculares lisas y fibras elásticas, formando una membrana limitante elástica interna. En las tres porciones estudiadas, la túnica media fue la capa más evidentes, constituida por fibras de colágeno, células musculares lisas dispuestas en forma circular y fibras elásticas, mostrando una variación en la proporción de elementos murales. Se evidenció la presencia de una lámina elástica externa, que marca la transición entre la túnica media y adventicia, formada la por condensación de las fibras elásticas. La túnica adventicia aórtica demostró ser poco organizada, presentando en su estructura predominantemente fibras de colágeno con algunas fibras musculares lisas aisladas o en pequeños fascículos entre unas pocas fibras elásticas.

PALABRAS CLAVE: Aorta; Zorrillo

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