Microanatomical Differences between Pangolin (Manis tricuspis) and Rat Ascending Aortae

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Citation

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Abstract

The microanatomy of the ascending aorta has hemodynamic implications. This study, therefore, aim to make a comparative analysis of the microanatomy of the ascending aorta in pangolin and rat since the different ways of life of each mammal can influence the rate of blood flow through the ascending aorta at an given period. Following sacrifice of animals, aortae recovered from pangolin (n=6), and rat (n=5) were processed for histological studies. Tissues were stained with haematoxylin and eosin, and orcein. The results of this investigation revealed differences in the microanatomy of the ascending aorta between pangolin and rat. The differences relate essentially to thickness of vascular layers, elastic fiber distribution, nuclear shapes, and perinuclear spaces. These differences correlate with animal size and perhaps modes of life.

INTRODUCTION

Pangolin is presumable a primitive mammal in that it presents some reptilian features. It primitiveness though, the African tree Pangolin seems to possess a remarkable cardiovascular function as apparent from comparatively prolonged contractions of its cardiac muscle following cutting away its whole heart from the body immediately after sacrifice by cervical dislocation.

The quest to deepen the knowledge of structural and cellular changes associated with cardiovascular functions and dysfunctions has led to the use of many animal models in cardiovascular studies (Bendeck et a., 1991; Wong and Langille, 1996; Cho et al., 1997; Leung et al 1977). Basic knowledge of normal morphofunctional properties of the cardiovascular system of any animal model is critical to determining whether such an animal will make a good model for further cardiovascular research. Swine model is extremely popular in cardiovascular research because of the anatomical and hemodynamic similarities to humans (Hughes 1986; Hughes et al. 2003). In addition to and pig models, there is enormous literature on the biomechanics of aorta in rat (Safar et al. 1998), rabbit (Chien 1978), dog (Ito et al. 1977), human (O'Rourke & Nichols 2005) and other species. Biomechanical analysis of aortic function is dependent on adequate delineation of its morphology and geometry which normally commence with basic investigations. For instance, Well et al., (1999) reported changes in mechanical properties and collagen cross–linking of the ovine thoracic aorta during perinatal development and postnatal maturation. In a novel study, Wasano and Yamamota (1983) explored the tridimensional architecture of the elastic tissue in the rat thoracic and femoral artery. Remodeling of internal elastic lamina during postal development has been suggested to have implication for transport of materials and cell-to-cell communication between the tunica intima and tunica media of rabbit arteries (Wong and Langille, 1996). However, this present study is the first, in literature, to report on the microanatomy of pangolin ascending aorta, and comparing it with that of rat. This investigation is significant in the sense that, comparative morphologic and histologic analysis can yield useful biometric information which is essential to our further understanding of mammalian cardiovascular functions and dysfunctions. Furthermore, pangolin is a threatened species, (Pangolin Specialty Group, 1996) and may go into extinction if preventive measures are not taken, it is therefore of importance to carry out all possible biomedical studies on the animal before any eventuality.

MATERIALS AND METHODS

PANGOLIN MATERIAL

Eleven animals, pangolin (n=6), rat (=5) were used for this study. Pangolins of both sexes weighing between 1500-3000g were sourced from local hunters in Asejire, Osun State and Iluke, Kogi State, Nigeria. The animals were

brought to the Animal Holdings of Department of Anatomy, University of Ilorin, Nigeria. Animals sacrificed the same day since no modality has been developed to ensure pangolin's adaptation to captivity, as they are very violent in the night.

Albino rats of both sexes weighing between 190g-220g were obtained from the Department of Biochemistry, University of Ilorin, Nigeria and brought to the Animal Holdings of the Department of Anatomy, University of Ilorin. They were fed with rat pellets (from Bendel Feed Limited, Ilorin, Nigeria) and provided water liberally

All animals were handled, cared for and maintained in accordance with the rules and guidelines of the animal right committee of the University Ilorin, Nigeria. The animals were thoroughly accessed, screened, and confirmed to be presumably free of any pathological conditions.

Animals were sacrificed through cervical dislocation, the left thoracic wall immediately incised and the ascending aorta identified and recovered. The ascending aorta was fixed in 10% formo saline and processed for histological study. Sections of 7µm were stained with in hematoxylin and eosin according to the method of…., in orcein as described by Slides were mounted on an Olympus binocular microscope interfaced with a JVC digital camera (S/No 10139477). The micrograph was display on the screen of a desktop connected to the camera. The micrograph was captured on the screen, edited (with Microsoft picture manager) and appropriately labeled.

RESULTS

The myocardial nuclei, as demonstrated in H&E stained sections, that is figure 1b, are more slender and elongated in rat, while that of pangolin, figure A demonstrates more perinuclear spaces and are more oval in shape. Also the fiber thickness is obviously larger in pangolin.

In orcein-stained cross section of the ascending aorta, the tunica intima is conspicuously wider, more-intensely stained in the pangolin than in the rat while the tunica adventitia is thinner in pangolin compared with rat. Elastic fibers stained more intensely in pangolin.

Amorphous collagen does not show any observable differences in both mammals' ascending aortae, though the tunica adventitia that was supposed to be more of collagen fibers was thinner in the pangolin compared with rat.

Figures A and B are H&E-stained cross sections of the ascending aortas of a pangolin and a rat respectively. These micrographs are taken from the tunica media where differences are apparent. Note the abundant perinuclear spaces in figure A and the comparatively slender nuclei in figure B. MF=muscle fiber; N= nucleus; PN= perinuclear ×3000

Figure 1

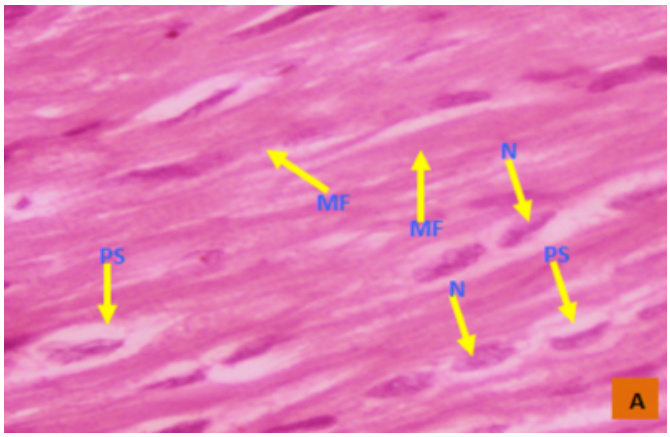
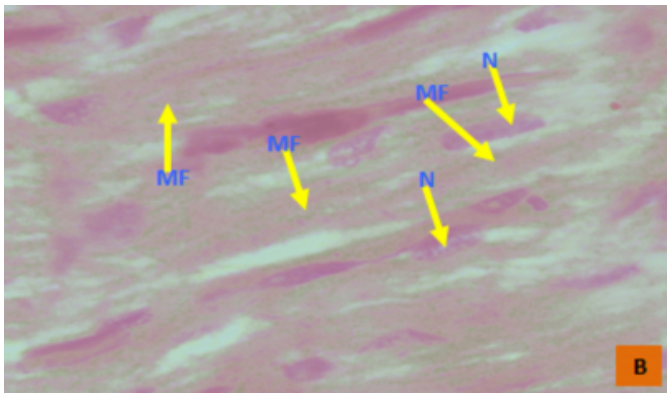


Figure 2



Figures C and D are orcein-stained, cross sections of the ascending aorta of a pangolin and a rat. The following differences are apparent

Differences in sizes of the layers of the tunica intima, tunica media and tunica adventitia

The intima is thicker and stained more intensely in for elastic fiber in Figure C

The adventitia is thinner in pangolin (figure C);

TI= tunica intima; TA= tunica adventitia; TM= tunica media; EF= elastic fiber. ×1200

Figure 3

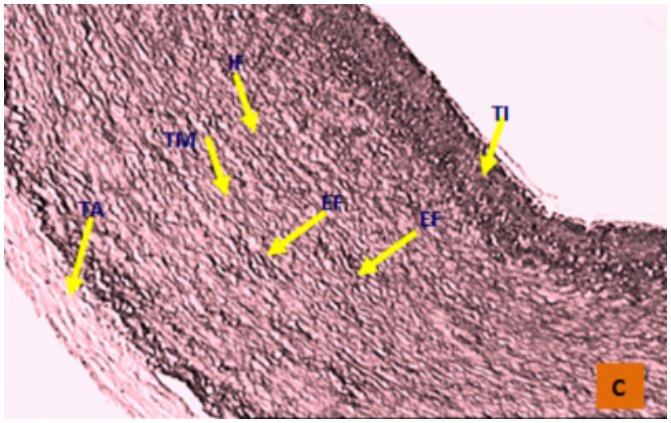
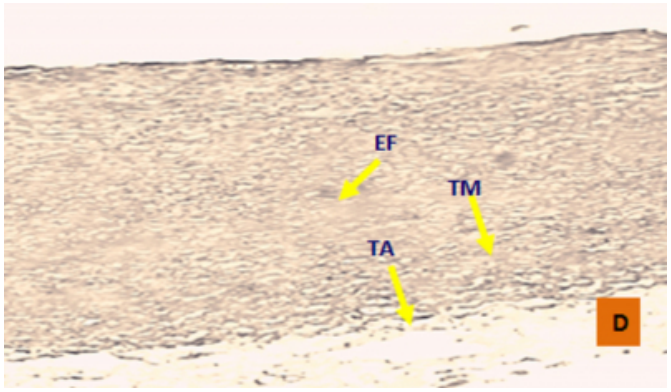


Figure 4



DISCUSSION

From this investigation, differences exist between the two mammals in the properties of their ascending aortae. The observable differences lie in the thickness or width of vascular layers, distribution of elastic fibers, nuclear shapes and perinuclear spaces.

When the probable functional implications of these structural differences are examined, there is a correlation to animal size and mode of life. The relatively bigger pangolin appears to exhibits a wider/thicker tunica intima and tunica media with a somewhat richer elastic fiber distribution. Earlier studies (Burton, 1954; Keech, 1960; Wasano and Yamamota, 1983; Well et al., 1999) have confirmed that, though vascular layers remain essentially the same in mammals, differences in properties such as thickness, elastic fiber distribution exist; and that the amount of pressure being transmitted through a vessel has implication for its structural architecture. A relatively bigger mammal (as in pangolin to rat) will require an aorta with thicker vascular layers and probably more elastic fibers, to handle its expected relatively larger cardiac output. Since the ascending aorta and arises directly from the heart, it is subjected to cyclic changes in blood pressure; high during ventricular contractions and low during ventricular relaxation. In fact, the pressure may soar very high during period of intense and vigorous activities. In order to compensate for these intermittent pressure alterations, an abundance of elastic fibers are located in the walls of these vessels. These elastic fibers content of a vessel is directly related to the hemodynamics pressure against its wall. The micro architectural properties of the vascular layers in each mammal appear suited for its mode of life. For instance, pangolin which is nocturnal animal, is almost totally passive throughout the day but extremely active, agile and even violent in the night. Expectedly, there will be extensive change in the pattern and quantity of cardiac output between these two states of life. Thus when the hemodynamic pressure is raised as a result of increased cardiac output during intensive activities, the thick tunica intima and media are well prepare to handle while the relatively thinner tunica adventitia allow adequate expansion and effective elastic recoil. Stated simply, collagen content is lower and the elastic fibre content is higher in the pangolin aorta as compared with the rat aorta which implies the pangolin aorta is more compliant than the rat aorta.

More perinuclear spaces in pangolin's vascular wall suggest its degree of mitochondria packaging which is an indication of higher metabolic activity.

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