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Short Paper

Histomorphologic study of the renal artery in post-natal life of sheep (*Ovis aries*)

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Summary

The purpose of this study was to gain more information on the structure of different layers of renal artery and comparing these structures in post-natal male and female sheep. To do so, right and left renal arteries of 6 adult and 6 newborn animals were dissected; the middle parts of arteries were only collected. After tissue processing using paraffin embedding method, 5–6-µm sections were cut and stained with haematoxylin and eosin, green Masson's trichrome and Verhoeff's elastic fiber methods. Three layers were identified in the wall of artery in both sexes. In tunica media the number of rows of circular smooth muscle cells was 15–25 rows in newborn and 30–40 in adult sheep. External elastic membrane was visible in adult and was structurally thinner than the internal membrane. Tunica adventitia was visible in all samples and collagen fibers and smooth muscles bundle were distinguished. The existence of these muscle bundles in external layer of renal artery was not reported previously in domestic animals and regarded as a new finding in the present study. These muscle bundles were thicker in adult than in newborn animals and probably have a relationship with the function of kidney's vascular system. It was concluded that these bundles may potentiate the tunica media muscle cells to prevent hypertension crisis.

Key words: Sheep, Renal artery, Histomorphology

Introduction

The medium-sized renal artery is one of the important vessels of the body, which supplies blood to kidney. While, the kidneys have just 1% of the body weight, they receive 16%–30% of the cardiac output and that is why they are well-developed. (Leeson *et al*., 1988; Banks, 1993; Dellmann and Eurell, 1998; Guyton and Hall, 2000).

There is comparatively little data in the literature on microscopic structure of the renal artery and vein in domestic animals. There are, however some studies on humans and some laboratory animals (Evans, 1960; Alekseevskikh, 1968, 1969; Fourman and Moffat, 1971; Osborne-pellegrin, 1978).

It has been shown that in the wall of the human renal artery, all layers are existed. The inner elastic membrane is separated into two and occasionally three layers of various thicknesses, among which single smooth muscle fibers are found. The outer elastic membrane is of regular thickness (Alekseevskikh, 1969). Apart from an outer elastic membrane, some authors have described a collagen and an elastic adventitia (Fourman and Moffat, 1971). The microscopic and ultrastructure of swine renal artery have been described before. It has been stated that in tunica media of swine's artery, mast cells were found. The electron microscopic observation showed that their granules had various sizes and shapes (Vodenicharov and Cirnuchanov, 1995). In rat, the renal artery showed a gradual transition from elastic type at its origin, with the presence of several elastic lamellae in the media, to a muscular type after its second branching at the hilus of the kidney (Osborne-pellegrin, 1978). Since no such study has been reported on the structure

of the renal artery in sheep, the present study was conducted to gain more information on the structure of different layers of renal artery in both sexes in post-natal life.

Materials and Methods

Both renal arteries from six adult Mehraban sheep and six newborn (three males and three females each) were used. The specimens were taken from the middle part of the left and right arteries immediately after slaughtering of the animals. The specimens were fixed in 10% buffered formalin. After tissue processing, paraffin 5–6-µm thick sections were cut and stained with hematoxylin-eosin (H&E), green Masson's trichrome and Verhoeff's elastic fiber (Luna, 1968) to be studied by light microscope.

Results

In the structure of renal artery of the sheep, all three layers are well-developed (Fig. 1). The endothelial layer was composed of one row of cells. Their nuclei were situated at various distances from each other. The subendothelial layer was irregularly oriented (Fig. 2).

The inner elastic membrane showed degrees of wrinkleness and was separated into two layers in adult (Figs. 2 and 3). The middle layer (tunica media) consisted of 15–25 rows of smooth muscle cells in newborn sheep and 30–40 in adults. A small amount of collagen fibers and considerable amount of elastic fibers were found between the smooth muscle cells (Fig. 4). The external elastic membrane was not structurally well-developed compared to internal membrane, particularly in the newborn animals (Figs. 5 and 6). The outer layer (tunica adventitia) consisted of irregular elastic and collagen fibers. However, alongside the expected structural appearance in this layer, some peculiarities were also found. In addition to collagen fibers, longitudinally-arranged smooth muscle bundles were seen in its structure in adult and newborn of both sexes. These muscle bundles structurally were similar to those of media and were thicker in adult than in newborn animals (Figs. 5 and 6).

Discussion

On the basis of the present study, three layers were identified in the wall of renal artery in both sexes and ages of sheep. However, the fact that in the adventitia of the artery smooth muscle bundles were found, was of particular interest. The internal elastic membrane was visible in all samples—adult and newborn—of both sexes and separated into two layers. In human, the inner elastic membrane was separated into two and occasionally three membranes of various thicknesses, among which single smooth muscle fiber was found (Alekseevskikh, 1969, 1968). In eight-month-old swine, the inner elastic membrane was cleaved into two layers, between which smooth muscle cells were situated (Vodenicharov and Cirnuchanov, 1995). In our study, tunica media consisted of 15–25 rows of smooth muscle cells in newborn and 30–40 in adult sheep in both sexes. In eight-month-old domestic swine, the middle shell (tunica media) consisted of 16–24 rows of smooth muscle cells with a small quantity of collagen and elastic fibers between them (Vodenicharov and Cirnuchanov, 1995). The tunica media of pial blood vessels of the cat and monkey as a muscular arteries consisted of pure population of smooth muscle cells, while endothelium was the only cell type found in the tunica intima (Pease and Molinari, 1960). In rat, the tunica adventitia was variable in thickness but usually revealed the same thickness as the media and consisted of fibroelastic connective tissue with collagen fibers which were located parallel with the longitudinal axis of the artery (Osborne-Pellegrin, 1978).

In the present study, the external elastic membrane was observed between tunica media and adventitia in all samples. The external elastic membrane, howeve, was not as well-developed as the internal membrane, especially in new-born animals. Longitudinally-arranged bundles of smooth muscles were seen in the adventitial layer. The presence of these longitudinally-oriented smooth muscles bundle in this layer was one of the most interesting findings in this study. So far, muscle bundles have been observed in the adventitial of large- and sometimes in

Fig. 1: Photomicrograph showing different layers of renal artery in adult male sheep. Lumen of artery (L), tunica intima (In), tunica media (Me), tunica adventitia (Ad) (green Masson's trichrome staining ×50)

Fig. 2: Photomicrograph showing different layers of renal artery in adult female sheep. Tunica intima (In), tunica media (Me), tunica adventitia (Ad), endothelial cell (Ec), subendothelial layer (Se), internal elastic membrane (IEm), outer layer (Ol), inner layer (Il) (green Masson's trichorme staining ×200)

Fig. 3: Photomicrograph showing two layers of internal elastic membrane of renal artery in adult female sheep. Internal elastic membrane (IEm), inner layer (Il), outer layer (Ol). (Verhoeff's elastic fiber staining ×720)

Fig. 4: Photomicrograph showing tunica media of renal artery in adult female sheep. Smooth muscle cell (SMc), elastic fiber (Ef), collagen fiber (Cf). (green Masson's trichrome staining ×200)

Fig. 5: Photomicrograph showing tunica adventitia of renal artery in adult female sheep. Collagen fiber (Cf), smooth muscle cells in the form of muscle bundle (SMb). External elastic membrane (EEm). (green Masson's trichrome ×200)

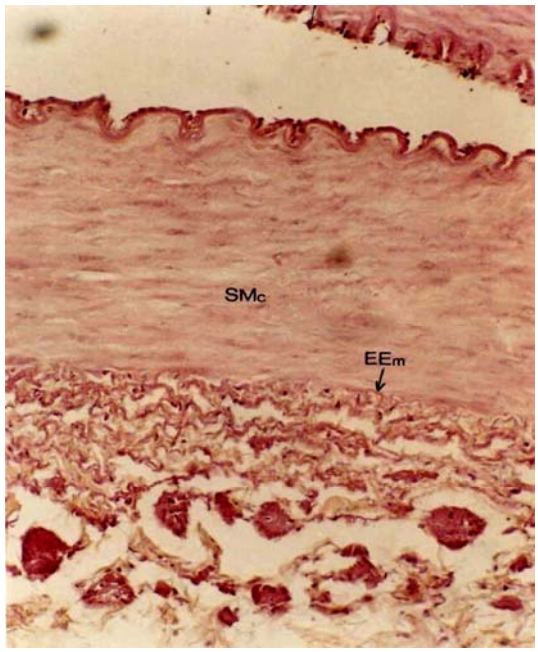

Fig. 6: Photomicrograph showing different layers of renal artery in newborn female sheep. Smooth muscle cell (SMc), external elastic membrane (EEm). (H&E staining ×130)

middle-sized vessels. The existence of these muscle bundles in external layer of renal artery was not reported previously in domestic animals and regarded as a new finding of the present study. These longitudinal smooth muscle bundles were similar in structure to those of the media and were thicker in adult than in newborn animals; there were no differences between male and female animals. Probably, they have a role in the function of the kidney vascular system. We concluded that these bundles may potentiate the tunica media muscle cells to prevent hypertension crisis and that they have a strengthening role and develop in response to the increased stress. Osborne-Pellegrin (1978), reported small strips of longitudinally-arranged smooth muscle in the adventitia of renal artery in rat, most often in the proximity at the branch points. They observed longitudinal adventitial strips of muscle in older rats in areas where the internal elastic lamina was absent. Ball *et al*. (1963) reported longitudinally-arranged smooth muscle in adventitia of anterior mesenteric artery of chicken and turkey. They stated that these fibers may have a relationship with the stress that applied parallel to the long axis of the artery.

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