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Medical Science

Coronary Arterial Elastic Fibres - A Histological Study in Mammals

KEYWORDS : Coronary Arteries, Elastic Fibres, Interventricular Arteries, Circumflex Arteries

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ABSTRACT

For comparison of the density of elastic fibres in coronary arterial wall of mammals tissue of their circumflex and interventricular branches from the adult hearts of human, buffalo, pig, goat dog and rabbit was obtained at constant levels to be preserved in 10% formalin. After processing paraffin sections of 10 micron thickness were stained with orcein and counter stained with haematoxylin and eosin. Circumflex as well as interventricular arteries in all the mammals showed + density of elastic fibres in tunica intima. There was ++ density of elastic fibres in tunica media of interventricular arteries and tunica adventitia of circumflex arteries while +++ density of elastic fibres in tunica media of circumflex arteries and in tunica adventitia of interventricular arteries was observed in all the mammals. It was concluded that distal to commencement of coronary arteries density of elastic fibres gradually decreases in tunica media and increases in tunica adventitia.

INTRODUCTION

Due to increasing incidence of coronary heart disease the present study of coronary arteries is drawing high attention of workers for the last 90 years (Ehrich *et al.* 1931)[1] and (Gross, *et al.* 1934)[2]. They have tried to make systemic histological studies of the main coronary vessels and myocardial twigs in order to determine the normal structure as represented in the first eight decades of life and to observe whether or not there were any significant differences in the myocardial vessels in the various parts of hearts. They however observed that variations in structure of coronary branches were not inconsiderable even for the same age period.

An electron microscopic study of coronary arteries was done by Parker (1958)[3]. Later on fine structure of coronary arteries was studied using light and electron microscope reported by Parker (1958)[3], Moore and Ruska (1957)[4]. The above workers have not only studied the general histology but have laid emphasis on the histochemical studies as well. They also drew special attention to the structural interrelationship of endothelium, subendothelial basement membrane, elastic complex and smooth muscle layers. They have concluded that such relationship might have important bearing on certain disease processes in the coronary arteries. Microstructure of human arteries was described by Keshaw Kumar (2001)[5] who reported that arterial elasticity was directly proportional to arterial proximity to the heart and arterial muscularity was directly proportional to arterial distance from the heart. Effect of tangential pressure of pulsation on tunica media of human arteries was observed by Keshaw Kumar (2002)[6] who found that arterial segments having equal length and equal pulsatory power have equal number of smooth muscle fibres in their tunica media. Keshaw Kumar (2015, 2015)[7, 8] created theory and laws of arterial elasticity or muscularity.

In the light of above investigations made by various workers this study was conducted to compare the density of elastic fibres in the tunica intima, tunica media, tunica adventitia of branches of coronary arteries at constant levels in different mammals.

MATERIAL AND METHODS

Hearts of human, buffalo, pig, goat, dog and rabbit (50 of each) were procured immediately after their death. Human hearts were procured from dissection room cadavers, hearts of buffalo, pig and goat were procured from slaughter house of Allahabad situated at Atala, hearts of dog were procured from experimental laboratory of Physiology department and hearts of rabbit were procured from experimental laboratory of Pharmacology department. These mammals were healthy and were of adult age group. Circumflex and interventricular branches of right and left coronary arteries were dissected in all the hearts and 0.5 cm long arterial segments were obtained from the following arteries.

1. Right circumflex artery 1 cm distal to its commencement.
2. Left circumflex artery 1 cm distal to its commencement.
3. Anterior interventricular artery 2 cm distal to its commencement.
4. Posterior interventricular artery 0.5 cm distal to its commencement.

The above mentioned sites of the arteries are the sites commonly effected during atherosclerosis as reported by Gross *et al.* (1934)[2]. Paraffin sections of 10 micron thickness were cut with the help of rotary microtome to be stained with orcein and counterstained with haematoxylin and eosin. Density of elastic fibres per magnified field was observed in tunica intima, tunica media and tunica adventitia of circumflex and interventricular branches of right and left coronary arteries in all the mammals.

Each layer of coronary arteries was graded as +, ++, +++ for density of elastic fibres per magnified filed with + representing minimum density and +++ representing maximum density of elastic fibres according to the criteria that density of elastic fibres per magnified field present in tunica media of human ascending aorta is always taken as ++++ as reported by Keshaw Kumar (2001, 2002)[5, 6]. Results were obtained as visual assessment by a single observer.

OBSERVATIONS

1. Circumflex Arteries (Fig. 1 and 3; Table I)

A. Tunica Intima

+ Density of elastic fibres was observed in tunica intima of right as well as left circumflex arteries of all the mammals.

B. Tunica Media

+++ Density of elastic fibres was observed in tunica media of right as well as left circumflex arteries of all the mammals.

C. Tunica Adventitia
++ Density of elastic fibres was observed in tunica adventitia of right as well as left circumflex arteries of all the mammals.

2. Interventricular Arteries (Fig. 2 and 4; Table II)
A. Tunica Intima
+ Density of elastic fibres was observed in tunica intima of anterior as well as posterior interventricular arteries of all the mammals.

B. Tunica Media
++ Density of elastic fibres was observed in tunica media of anterior as well as posterior interventricular arteries of all the mammals.

C. Tunica Adventitia
+++ Density of elastic fibres was observed in tunica adventitia of anterior as well as posterior interventricular arteries of all the mammals.

DISCUSSION
Distal to the commencement of coronary arteries from the ascending aorta the density of elastic fibres in tunica media was seen gradually decreasing in the branches of coronary arteries in all the mammals. In the tunica intima, however, density of elastic fibres was observed to be equal at all the levels of coronary arteries but in the tunica adventitia the density of elastic fibres was seen increasing distal the commencement of coronary arteries from ascending aorta in branches of coronary arteries as compared to the density in the tunica media.

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Fig. 1 - Transverse section of left coronary artery of dog. 1 cm distal to its commencement showing +++ density of elastic fibres in its tunica media. (Orcein X 100)

Fig. 2 - Transverse section of anterior interventricular artery of pig. 2 cm distal to its commencement showing ++ density of elastic fibers in its tunica media and +++ density of elastic fibres in its tunica adventitia. (Orcein X 100)

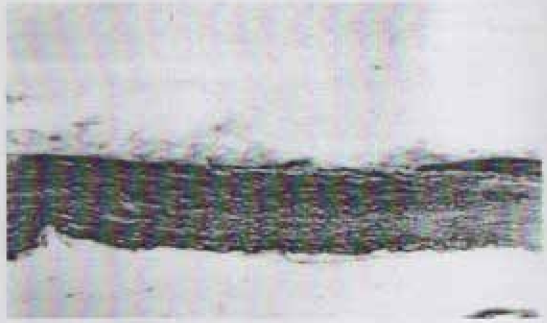

Fig. 3 - Transverse section of right coronary artery of goat. 1 cm distal to its commencement showing +++ density of elastic fibres in its tunica media. (Orcein X 100.)

Fig. 4 - Transverse section of posterior interventricular artery of buffalo 0.5 cm distal to its commencement showing ++ density of elastic fibres in its tunica media and +++ density of elastic fibres in its tunica adventitia. (Orcein X 100)

Table - I
Density of elastic fibrers in circumflex branches of coronary arteries of mammals

Mammals	Right circumflex artery			Left circumflex artery		
	Tunica intima	Tunica media	Dunica adventitia	Tunica intima	Tunica media	Dunica adventitia
Human	+	+++	++	+	+++	++
Buffalo	+	+++	++	+	+++	++
Pig	+	+++	++	+	+++	++
Goat	+	+++	++	+	+++	++
Dog	+	+++	++	+	+++	++
Rabbit	+	+++	++	+	+++	++

Table - II
Density of elastic fibrers in interventricular branches of coronary arteries of mammals

Mammals	Posterior interventricular artery			anterior interventricular artery		
	Tunica intima	Tunica media	Dunica adventitia	Tunica intima	Tunica media	Dunica adventitia
Human	+	++	+++	+	++	+++
Buffalo	+	++	+++	+	++	+++
Pig	+	++	+++	+	++	+++

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Goat	+	++	+++	+	++	+++
Dog	+	++	+++	+	++	+++
Rabbit	+	++	+++	+	++	+++

Parker (1958)[3] observed endothelial cells of rabbit coronary arteries sending filiform processes towards the tunica media through fenestrae in the internal elastic lamina. Moore *et al.* (1957)[4] saw a similar arrangement in mammalian arteries and postulated that the elastic lamina was not permeable and thus required windows and endothelial processes to supply nutrition to the underlying smooth muscle. Numerous cytoplasmic protrustions were endothelial and or smooth muscle cells were found in the subendothelial space between adjacent aggregations of elastic fibres in the rat coronary artery by Spiro and Wiener (1963)[9]. According to them the presence of many small vesicles as well as large droplets in the basement membrane, elastic complex suggests that transport occurs across this layer. Their observation suggests that the transport of solutes from the arterial lumen is important in the metabolic process of the smooth muscle cells.

Boucek (1963)[10] observed in dog coronary artery that internal elastic lamina was connected to adventitia by elastic and collagen fibres. A number of workers including Dempsey and Lansing (1954)[11], Dees (1923)[12], Lansing (1952)[13] and Hall, *et al.* (1955)[14] by utilizing elastase trypsin or mechanical fragmentation of fibres have reported an associated fine fibrous component.

Dempsey and Lansing (1954)[11] observed with the electron microscope that partially digested fibres are seen to be composed of small fibrils at the frayed edges. If the digestion is prolonged this process of fraying of large fibrils continues until only short filaments remain. These coiled fibrous elements were of great interest because of the role they might have played in the elastic properties of elastic tissue. In mammalian arteries Dees (1923)[12] and Benninghoff (1930), observed fenestrae in the internal elastic lamina and filiform processes of endothelial cells were observed to pass through these fenestrae towards the tunica media. The same was also described in mammalian arterioles by Moore and Ruska (1957)[4]. In the present study fenestrae are observed in internal elastic lamina of coronary arteries but filiform processes of endothelial cells passing through fenestrae could not be seen due to light microsopic study.

Elastic strands branching from the internal elastic lamina have been observed extending into the tunica media between smooth muscle cells. The same have been also predicted by light microscopic study of Bennighoff (1930)[15]. Between the smooth muscle cells elastic fibres could be seen lying disposed as described by the workers in smooth muscle elsewhere, Pease (1955)[16], Moore and Ruska (1957)[4].

Loosely packed elastic fibres have been noticed to make up bulk of the tunica adventitia of coronary arteries. The elastic fibres were similar in appearance to those of internal elastic lamina. At many places these were seen concentrated along the border of tunica media of the coronary artery forming an ill defined external elastic lamina similar to that described by Gross *et al.* (1934)[2] and Benninghoff (1930)[15].

Therefore, it is concluded that distal to commencement of coronary arteries density of elastic fibres gradually decreases in tunica media and increases in tunica adventitia.

Maximum density of elastic fibres in tunica media near the aortico coronary junctions is due to maximum expansion of coronary arteries at this place during systole of heart. This expansion gradually decreases as we pass away from aortico coronary junctions therefore; density of elastic fibres also decreases gradually in tunica media of coronary arteries distal to artico coronary junctions as reported by Keshaw Kumar (2001)[5].

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