

# "Instead of Arterial Size Arterial Function Makes an Artery Elastic or Muscular"- Theory of Arterial Elasticity or Muscularity



## Medical Science

**KEYWORDS :** Ascending aorta, Pulmonary trunk, Elastic fibres, Smooth muscle fibres.

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### ABSTRACT

*In order to create theory of arterial elasticity or muscularity tissue of ascending aorta and pulmonary trunk was obtained at constant levels from human, buffalo, pig, goat, dog rabbit and rat of adult age group to be preserved in 10% formalin. After processing paraffin sections of 10 micron thickness were stained with orcein and counterstained with haematoxylin and eosin. Density of elastic fibres was observed + in tunica intima ++++ in tunica media and +++ in tunica adventitia while density of smooth muscle fibres was observed + in tunica media and nil in tunica intima as well as tunica adventitia of ascending aorta and pulmonary trunk per magnified field in all the mammals studied. It was concluded that "Instead of arterial size, arterial function makes an artery elastic or muscular"-Theory of arterial elasticity or muscularity created by Dr. Keshaw Kumar.*

### INTRODUCTION

In the past various histological studies on ascending aorta and pulmonary trunk have been done by Boucek (1963)<sup>1</sup>, Duff et.al. (1957)<sup>2</sup>, Gerrity and Cliff (1972)<sup>3</sup>, Gray et. al. (1953)<sup>4</sup>, Haust et.al. (1965)<sup>5</sup>, Harkness et.al. (1957)<sup>6</sup>, Hass (1943)<sup>7</sup>, Keech (1963)<sup>8</sup>, Laitinen (1963)<sup>9</sup>, Ahmed (1967)<sup>10</sup>, Pease (1955)<sup>11</sup>, Robert, C. Buck (1979)<sup>12</sup>, Saxton (1942)<sup>13</sup>, Smith et.al. (1951)<sup>14</sup> and Foster (1909)<sup>15</sup>. Keshaw Kumar (2010)<sup>16</sup> observed elastic fibres in ascending aorta and pulmonary trunk of mammals. Keshaw Kumar (2015)<sup>17</sup> created three laws to arterial elasticity or muscularity.

Present study was conducted to create theory of elasticity or muscularity which is not available in the literature as yet.

### MATERIAL AND METHODS

Hearts of human, buffalo, pig, goat, dog, rabbit and rat (10) of each were procured from various sources. These mammals were of adult age group belonging to following orders of class mammalia.

- Rodentia e.g. rat
- Lagomorpha e.g. rabbit
- Carnivora e.g. dog
- Primate e.g. human
- Artiodactyla e.g. buffalo, pig, goat

Tissue of ascending aorta and pulmonary trunk was taken immediately distal to their commencements to be preserved in 10% formalin. Paraffin blocks were prepared after processing and sections of 10micron thickness were cut with the help of rotary microtome to be stained with orcein and counterstained with haematoxylin and eosin.

Each layer of ascending aorta as well as pulmonary trunk in each mammal was graded as +, ++, +++ and ++++ according to density of elastic fibres/smooth muscle fibres per magnified field with + representing minimum density and ++++ representing maximum density of elastic fibres/smooth muscle fibres. All the observations were recorded by visual assessment by a single observer.

### OBSERVATIONS

(Table-I, II, III, IV and Fig-1, 2, 3, 4)

#### Tunica adventitia :-

In tunica adventitia of ascending aorta as well as pulmonary trunk density of elastic fibres was observed +++ while density of smooth muscle fibres was observed nil per magnified field in all the mammals studied.

#### Tunica media:-

In tunica media of ascending aorta as well as pulmonary trunk density of elastic fibres was observed ++++ while density of

smooth muscle fibres was observed + per magnified field in all the mammals studied.

#### Tunica intima:-

In tunica intima of ascending aorta as well as pulmonary trunk density of elastic fibres was observed + while density of smooth muscle fibres was observed nil per magnified field in all the mammals studied.

**Table- I**

**Elastic fibres in ascending aorta of mammals**

Mammals	Tunica intima	Tunica media	Tunica adventitia
Human	+	++++	+++
Buffalo	+	++++	+++
Pig	+	++++	+++
Goat	+	++++	+++
Dog	+	++++	+++
Rabbit	+	++++	+++
Rat	+	++++	+++

**Table- II**

**Elastic fibres in pulmonary trunk of mammals**

Mammals	Tunica intima	Tunica media	Tunica adventitia
Human	+	++++	+++
Buffalo	+	++++	+++
Pig	+	++++	+++
Goat	+	++++	+++
Dog	+	++++	+++
Rabbit	+	++++	+++
Rat	+	++++	+++

**Table- III**

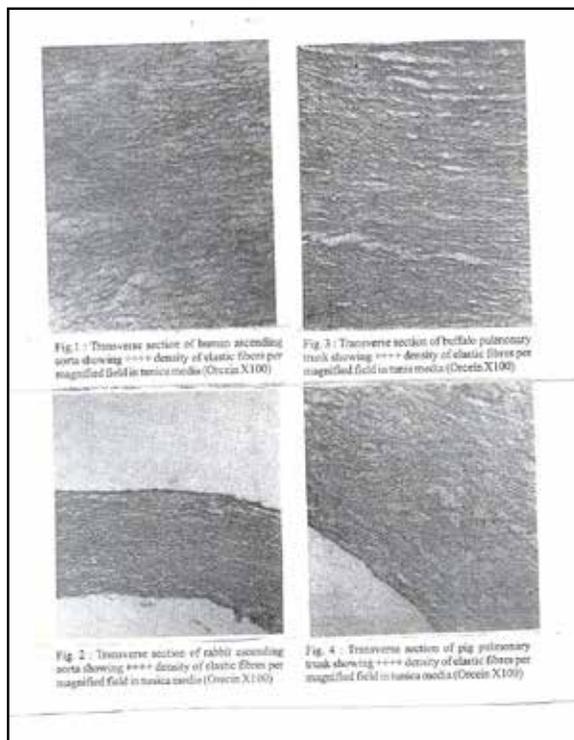
**Smooth muscle fibres in ascending aorta of mammals**

Mammals	Tunica intima	Tunica media	Tunica adventitia
Human	Nil	+	Nil
Buffalo	Nil	+	Nil
Pig	Nil	+	Nil
Goat	Nil	+	Nil
Dog	Nil	+	Nil
Rabbit	Nil	+	Nil
Rat	Nil	+	Nil

**Table- IV**

**Smooth muscle fibres in pulmonary trunk of mammals**

Mammals	Tunica intima	Tunica media	Tunica adventitia
Human	Nil	+	Nil
Buffalo	Nil	+	Nil
Pig	Nil	+	Nil
Goat	Nil	+	Nil
Dog	Nil	+	Nil
Rabbit	Nil	+	Nil
Rat	Nil	+	Nil



## DISCUSSION

In the present study the size (wall thickness and lumen circumference) of ascending aorta and pulmonary trunk varies considerably in all the mammals studied but as regards the density of elastic fibres and smooth muscle fibres in tunica intima tunica media and tunica adventitia is concerned their histological structure is same. Findings of present study regarding elastic fibres and smooth muscle fibres in ascending aorta and pulmonary trunk resemble with its findings of Boucek (1963)<sup>1</sup>, Duff et.al. (1957)<sup>2</sup>, Gerrity and Cliff (1972)<sup>3</sup>, Haust et.al. (1965)<sup>5</sup>, Ahmed (1967)<sup>10</sup>, Robert, C. Buck (1979)<sup>12</sup>, Smith et.al. (1951)<sup>14</sup>, Hass (1943)<sup>7</sup>, Keech (1960)<sup>8</sup>, Foster (1909)<sup>15</sup> and Keshaw Kumar (2010)<sup>16</sup> who had also reported maximum distribution of elastic fibres and minimum distribution of smooth muscle fibres in tunica media, moderate distribution of elastic fibres and nil distribution of smooth muscle fibres in tunica adventitia and minimum distribution of elastic fibres and nil distribution of smooth muscle fibres in tunica intima of ascending aorta as well as pulmonary trunk.

In the ascending aorta as well as pulmonary trunk tunica intima and tunica adventitia are very thin therefore, almost the entire thickness of wall is formed by tunica media in all the mammals studied. Wall thickness of ascending aorta is thrice more than the wall thickness of pulmonary trunk due to thrice more pulsatory power of ascending aorta than the pulsatory power of pulmonary trunk (Keshaw Kumar 1993, 2015)<sup>18,21</sup>.

In ascending aorta as well as pulmonary trunk tunica media shows +++ density of elastic fibres and + density of smooth muscle fibres per magnified field which can be taken as a standard to study the elasticity and muscularity of the arteries situated in any part of the body (Keshaw Kumar, 2002)<sup>19</sup>. Tunica media is the functional component of arterial wall expanding during systole of heart and contracting during diastole of heart due to elastic fibres and smooth muscle fibres present in it. Elasticity and muscularity of ascending aorta equals with the elasticity and muscularity of pulmonary trunk due to equal density of elastic fibres as well as smooth muscle fibres present in their tunica media per magnified field (Keshaw Kumar 2001)<sup>20</sup>. Elastic arteries are not always of large size and muscular arteries are

not always of medium size because arterial elasticity/muscularity depends on the tunica medial density of elastic fibres/smooth muscle fibres (Keshaw Kumar 2001, 2015)<sup>20,17</sup>.

In the present study size (wall thickness and lumen circumference) of ascending aorta as well as pulmonary trunk of buffalo is much larger than the size (wall thickness and lumen circumference) of ascending aorta as well as pulmonary trunk of rabbit but in buffalo as well as in rabbit the elasticity and muscularity of ascending aorta as well as pulmonary trunk is same. Actually it is the function and not the size of an artery which makes it elastic or muscular. In other words "Instead of arterial size arterial function makes an artery elastic or muscular" - Theory of elasticity or muscularity created by Dr. Keshaw Kumar.

Function of tunia media of ascending aorta/pulmonary trunk in buffalo as well as in rabbit is same i.e. maximum arterial expansion during systole of heart and minimum arterial contraction during diastole of heart because arterial expansion is directly proportional to arterial elasticity and arterial contraction is directly proportional to arterial muscularity (Keshaw Kumar 2001, 2015)<sup>20,17</sup>. Therefore ascending aorta and pulmonary trunk in all the mammals are maximum elastic and minimum muscular, which can be taken as a standard to study not only the elasticity and muscularity of arteries but also the expansion and contraction of arteries situated in the various parts of body.

Size of an artery depends upon the wall thickness and lumen circumference of that artery which depends on the size of a mammal. Elasticity / muscularity of an artery depends upon the tunica media density of elastic fibre/smooth muscle fibres per magnified field in that artery which depends on arterial expansion during systole of heart and arterial contraction during diastole of heart. Ascending aorta and pulmonary trunk both are maximum elastic and minimum muscular arteries to permit maximum expansion of their arterial wall during systole of heart and minimum contraction of their arterial wall during diastole of heart.

If the density of elastic fibres is more than the density of smooth muscle fibres per magnified field in tunica media, it is known as elastic artery and if density of smooth muscle fibres is more than the density of elastic fibres per magnified field in tunica media it is known as muscular artery (Keshaw Kumar 2001, 2015)<sup>20,17</sup>. Size of an elastic artery/muscular artery varies considerably from mammal to mammal but its tunica media density of elastic fibres/smooth muscle fibres remains same because function of elastic/muscular artery is always same i.e. expansion during systole of heart and contraction during diastole of heart (Keshaw Kumar 2015)<sup>17</sup>. Therefore tunica media density of elastic fibres/smooth muscle fibres depends on an arterial function and not on arterial size. Size of an elastic/muscular artery depends upon the size of mammal. Function of an elastic/muscular artery is always same only its size varies in mammals. Therefore it is concluded that "Instead of arterial size, arterial function makes an artery elastic or muscular"-Theory of arterial elasticity or muscularity created by Dr. Keshaw Kumar.

## REFERENCE

1. Boucek, R.J.R. Takashita and R. Fojaco. Functional anatomy of ascending aorta and coronary ostia (dog) *Am. J. Anat* (1963) (inpress).
2. Duff, G.L., G.C. Mcmillon and A.C. Ritchie. The morphology of early atherosclerotic lesions of aorta demonstrated by the surface technique in rabbits fed cholesterol together with a description of the anatomy of intima of rabbits aorta and spontaneous lesions which occur in it. *Am. J. Path* (1957) Vol. 33 : 845-873.
3. Gerrity, R.G. and W.J. Cliff. the aortic tunica intima in young and ageing rats. *Exp. Mol. Pathol.* (1972) Vol. 16 : 382-402.
4. Gray S.H., Nandier F.P., Blanche J.O., Zuckner, J. and Blumenthol H.T. Ageing process of aorta and pulmonary artery in negro and white races. *Arch. Path.* (1953) 56 : 238-253.
5. Haust M.D., R.H. More, S.A. Bencosmenad J.V. Balis. Elastogenesis in human aorta - an electronmicroscopic study. *Exp. Mol. Pathol.* (1965) 4 : 508-524.
6. Margaret, L.R. and Harkness, R.D. The collagen and elastin content of the arterial wall in the dog. *Proc. Roy. Soc. B* (1957) 146 : 541-551.
7. Hass, G.M. Elastic tissue relationship between the structures of ageing aorta and the properties of isolated aortic elastic tissue. *Arch. Path.* (1943) 35 : 429-458.
8. Keech, M.K. Electron microscope study of normal rat aorta. *J. Biophys. Biochem Cytol.* (1960) 7 : 533-538.
9. Laitinen, E. Changes in the elemental structure of the aorta in human and experimental atherosclerosis. *Acta. Path. microbiol. Scand. Suppl.* (1963) 167.
10. M.M. ahmed. Age and Sex differences in the structure of tunica media of human aorta. *Acta Anatomica* (1967) 66 : 45-58.
11. Pease, D. C. Electron microscopy of the aorta. *Anat. Rec.* (1955) 121 : 350-357.
12. Robert, C. Buck. The longitudinal orientation of structures in the subendothelial space of rat aorta. *Am. J. Anat.* (1979) 156 : 1-13.
13. Saxton, J.A. Elastic properties of rabbit aorta in relation to age. *Arch. Path.* (1942) 34 : 262-274.
14. Smith, C. Seitner, M.M. and Wang, H.P. Ageing changes in the tunica media of the aorta. *Anat. Rec.* (1951) 109 : 13-39.
15. Foster, L.L. Changes occurring in the elastic fibres of aorta with advancing age. *J. Med. Res.* (1909) 2 : 297-311.
16. Keshaw Kumar, Elastic fibres in ascending aorta and pulmonary trunk of mammals. *Journal of Anatomical Sciences* (2010) Vol. 18 (1) : 5-10.
17. Keshaw Kumar. Laws of arterial elasticity or muscularity. *International Journal of Scientific Research.* (2015) Vol. 4 (4) : 19-21.
18. Keshaw Kumar. Pulsatory power of human arteries. *Vijnana Parishad Anusandhan Patrika* (1993) Vol. 36(2) : 115-120.
19. Keshaw Kumar. Effect of tangential pressure of pulsation on tunica media of human arteries. *Journal of Anatomical Society of India* (2002) Vol. 51 (1) : 35-38.
20. Keshaw Kumar. Microstructure of human arteries. *Journal of Anatomical Society of India.* (2001) Vol. 50 (2) : 137-140.
21. Keshaw Kumar. Laws of arterial pulsation. *International Journal of Scientific Research.* Vol. 4 (1) : 65-66.