Laws of Arterial Pulsation

Medical Science

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ABSTRACT

In order to confirm the laws of arterial pulsation created by Keshaw Kumar (1993)1 lumen circumference and wall thickness of ascending aorta, pulmonary trunk and femoral artery was measured 1cm distal to their commencements in 300 human adults during autopsy who had no history of suffering from any cardiovascular disease. The mean thickness of wall in case of ascending aorta was 1.5 mm while in case of pulmonary trunk it was 0.5 mm showing the same ratio which was present between their pulse pressures i.e. 50 mm of Hg in ascending aorta and 17mm of Hg in the pulmonary trunk (Keshaw Kumar 2007)2 . The mean circumference of lumen of ascending aorta was equal to that of pulmonary trunk i.e. 60 mm resembling with the stroke volume of blood i.e. 60 ml. Mean circumference of lumen of femoral artery was 16 mm while its mean thickness of wall equaled with that of pulmonary trunk i.e. 0.5 mm. On the basis of these observations following laws of arterial pulsation created by Keshaw Kumar (1993)1 were confirmed.
(1)   Pulsatory power of an artery is equal to the pulse pressure multiplied by volume of blood entering the lumen of that artery during each heart beat.
(2)   Wall (Tunica media) thickness of an artery is directly proportional to the pulsatory power of that artery having 1 mm wall thickness is reported as 2000 Joule per heart beat.
(3)   Lumen circumference of an artery in millimeters equals with the volume of blood in millilitres entering the lumen of that artery during each heart beat.

INTRODUCTION

In the past Wright (1969)[3] performed dissection study and mensuration of the human aortic arch. Green-field and Patel (1962)[4] observed the relation between pressure and diameter in the ascending aorta in man. Remington (1963)[5] studied the physiology of the aorta and major arteries. Wehn (1957)[6] described pulsatory activity of peripheral arteries. Keshaw Kumar (1993)[1] calculated pulsatory power of human arteries and created three laws of arterial pulsation. Present study was conducted to confirm laws of arterial pulsation in human arteries created by Keshaw Kumar (1993)[1].

MATERIAL AND METHODS

Lumen circumference and wall thickness of ascending aorta, pulmonary trunk and femoral artery were measured 1 cm distal to their commencements after opening their lumen by cutting their wall longitudinally in 300 human adults during autopsy who had no history of suffering from any cardiovascular disease. Mean of wall thickness as well as lumen circumference was cal-

culated separately for each artery. Pulse pressure of blood 50mm Hg in ascending aorta, 17 mm Hg in pulmonary trunk (Keshaw Kumar 2007)[2] and 63 mm Hg in femoral artery (Wehn 1957)[6] was taken as mean of pulse pressure of blood flowing in lumen of these arteries.

OBSERVATIONS (Tables I, II, III & IV)

Mean thickness of wall in case of ascending aorta was 1.5 mm while in case of pulmonary trunk it was 0.5 mm showing the same ratio which was present between their pulse pressures i.e. 50 mm of Hg in ascending aorta and 17 mm of Hg in the pulmonary trunk. The mean circumference of lumen of ascending aorta was equal to that of pulmonary trunk i.e. 60 mm resembling with the stroke volume of blood i.e. 60 ml. the mean circumference of lumen of femoral artery was 16 mm while its mean thickness of wall equaled with that of pulmonary trunk i.e. 0.5 mm.

TABLE – I
Pulsatory power of great arterial trunks

Arteries	Volume of blood entering the lumen during each heart beat	Pulse pressure of blood	Pulsatory power
Ascending aorta	60 ml	50 mm of Hg	60x50=3000 Joule per heart beat
Pulmonary trunk	60 ml	17 mm of Hg	60x17=1020 Joule per heart beat

TABLE – II
Stroke volume of blood and lumen circumference of great arterial trunks

Arteries	Mean circumference of lumen	Volume of blood entering the lumen during each heart beat
Ascending aorta	60 mm	60 ml
Pulmonary trunk	60 mm	60 ml

TABLE – III
Proposition between pulsatory power and wall thickness of great arterial trunks

Wall thickness and pulsatory power	Ascending aorta	Pulmonary trunk	Ratio
Mean thickness of wall	1.5 mm	0.5 mm	3:1
Pulsatory power	3000 Joule per heart beat	1020 Joule per heart beat	3:1

TABLE – IV

Pulsatory power of pulmonary trunk and   femoral artery

Arteries	Mean thick ness of wall	Lumen circumference	Volume of blood entering the lumen during each heart beat	Pulse pressure	Pulsatory power
Pulmonary trunk	0.5 mm	60 mm	60 ml	17 mm of Hg	1020 Joule per heart beat
Femoral artery	0.5 mm	16 mm	16 ml	63 mm of Hg	1008 Joule per heart beat

DISCUSSION

Aorta is not a static organ, it is in fact, a dynamic structure, its inherent distensibility being responsible, at least in part for the pulse wave pattern produced by left ventricular ejection (Remington, 1963)[5]. Further more, it has also been shown that changes in circumference and diameter may correlate quite closely with intra aortic pressure changes (Greenfield and Patel, 1962)[4]. Pulse pressure of blood varies considerably in the peripheral arteries (Wehn, 1957)[6].

In human ascending aorta as well as pulmonary trunk 60 ml volume of blood enters during each heart beat. Pulse pressure of blood in ascending aorta is 50 mm of Hg (Keshaw Kumar 2007)[2]. After multiplying 60 ml by 50 mm Hg we can get pulsatory power of ascending aorta i.e. 3000 Joule per heart beat.

Similarly after multiplying the pulse pressure of blood in pulmonary trunk i.e. 17 mm Hg (Keshaw Kumar 2007)[2] by the volume of blood entering its lumen during each heart beat i.e. 60 ml. we can get the pulsatory power of pulmonary trunk i.e. 1020 Joule per heart beat.

If an artery having 1.5 mm wall thickness has 3000 Joule per heart beat pulsatory power then the artery having 1mm wall thickness will have 2000 Joule per heart beat pulsatory power. Almost the entire thickness of wall in case of ascending aorta and pulmonary trunk is contributed by their tunica media because tunica adventitia in these arteries is very thin like their tunica intima.

Pulsatory power of pulmonary trunk is three times less than the pulsatory power of ascending aorta because wall thickness of pulmonary trunk is also three times less than the wall thickness of ascending aorta. Therefore, wall thicknesses of these arteries are directly proportional to their pulsatory powers.

Ascending aorta and pulmonary trunk both have equal lumen circumference i.e. 60 mm and volume of blood entering the lumen of these arteries during each heart beat (Stroke volume of blood) is also equal i.e. 60ml (Keshaw Kumar 2007)[2]. Therefore, lumen circumference of these arteries in millimeters equals with the volume of blood in millilitres entering the lumen of these arteries during each heart beat.

Wall thickness of femoral artery is equal to wall thickness of pulmonary trunk i.e. 0.5 mm, therefore, pulsatory powers of these arteries are also equal. Volume of blood entering the lumen of femoral artery during each heart beat is 16 ml because

lumen circumference of femoral artery is 16 mm. Pulse pressure of blood in femoral artery is 63mm of Hg as noted by Hurthle (1934, 1935 cited by Wehn, 1957)[6]. Therefore, if 63 mm of Hg pulse pressure is multiplied by 16 ml volume of blood we can get pulsatory power of femoral artery i.e. 1008 Joule per heart beat which is approximately equal to the pulsatory power of pulmonary trunk i.e. 1020 Joule per heart beat.

The unit of power in physics is Joule per second but to accept this unit of power in case of arteries will be possible only when in each person heart rate remains always 60 beats per minute which is impossible, therefore, Keshaw Kumar (1993)[1] changed the unit of power from Joule per second to Joule per heart beat in case of pulsatory power of arteries. On the basis of obser

vations recorded in the present study following laws of arterial pulsation created by Keshaw Kumar (1993)[1] are being confirmed.

1 Pulsatory power of an artery is equal to pulse pressure multiplied by volume of blood entering the lumen of that artery during each heart beat.

2 Wall (Tunica media) thickness of an artery is directly proportional to pulsatory power of that artery having 1 mm wall thickness is reported as 2000 Joule per heart beat.

3 Lumen circumference of an artery in millimeters equals to the volume of blood in millilitres entering the lumen of that artery during each heart beat.

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