Original Research Paper

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Alteration in Coronary Arterial Pattern Alters Coronary Arterial Pulse Pressure - Theory of Coronary Pattern and Pulse Pressure

Anatomy

KEYWORDS: Pulse pressure, Coronary artery, Dominance, Heart.

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ABSTRACT

In order to observe the effect of alteration of coronary arterial pattern on coronary arterial pulse pressure lumen circumference and wall thickness of both the coronary arteries were measured 1cm. distal to their commencements in 90 human adults (45 with right coronary arterial dominance and 45 with left coronary arterial dominance) who had no history of suffering from any cardiovascular disease. Pulsatory power, pulse pressure and volume of blood entering the lumen were calculated according to laws of arterial pulsation (Keshaw Kumar 1993, 2015)1,2.

In case of right coronary, arterial dominance mean left coronary arterial pulse pressure was 60mm Hg and mean right coronary arterial pulse pressure was 20mm. Hg. while in case of left coronary arterial dominance mean left coronary arterial pulse pressure was 64mm Hg. and mean right coronary arterial pulse pressure was 16mm. Hg. It was concluded that alteration in coronary arterial pattern alters coronary arterial pulse pressure-Theory of coronary pattern and pulse pressure.

INTRODUCTION

Blumgart, et.al. (1940)[3], white (1951)[4], Mathur (1957)[5] and All work (1987)[6] reported increased incidence of coronary heart disease in persons with left coronary arterial dominance. Schlesinger (1940)[7] found relation of anatomic pattern to pathologic conditions of the coronary arteries. James (1965)[8] noticed anatomy of coronary arteries in health and disease. Keshaw Kumar (1993, 2015)[1,2] calculated pulsatory power of human arteries. Keshaw Kumar (1996)[9] established the increasing pulse pressure of blood as a cause of arterial atherosclerosis. Keshaw Kumar (2003)[10] described anatomy of human coronary arterial pulsation. Keshaw Kumar (2003)[11] observed anatomy of human coronary arterial lipid accumulation. Keshaw Kumar (2015)[12] created laws of arterial blood circulation. Keshaw Kumar (2008, 2016)[13,14] interrelated coronary heart disease with the coronary arterial pattern. Present study was conducted to compare right and left coronary arterial pulse pressure in right coronary arterial dominance with the right and left coronary arterial pulse pressure in left coronary arterial dominance to observe the effect of alteration of coronary arterial pattern in coronary arterial pulse pressure which was not available in literature as yet.

MATERIAL AND METHOD

During autopsy arterial segments of right coronary artery and left coronary artery were obtained 1cm. distal to their commencements to be preserved in 10% formalin in 45 human adults with right coronary arterial dominance (RCAD Group) and 45 human adults with left coronary arterial dominance (LCAD Group) who had no history of suffering from any cardiovascular disease.

Lumen circumference was measured in all the arterial segments by cutting their wall longitudinally. Paraffin sections of 10 micron thickness of all the arterial segments were stained with orcein and PAS to obtain 100 times magnified photomicrographs of all the stained sections. In all the photomicrographs thickness of tunica media was measured between external elastic lamina and internal elastic lamina. Mean of the lumen circumference and mean of the thickness of tunica media were calculated for the right coronary artery and left coronary artery separately in RCAD group and LCAD group. Later on actual thickness of tunica media was obtained after dividing the mean thickness of tunica media of photomicrographs by 100 because photomicrographs were taken at 100 times magnification.

Pulsatory power, pulse pressure and volume of blood entering the lumen of coronary arteries during each heart beat were calculated according to following laws of arterial pulsation (Keshaw Kumar 1993, 2015)[1,2].

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 1mm. 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 milliliters entering the lumen of that artery during each heart beat.

OBSERVATIONS

Left Coronary Arterial dominance (LCAD) Group :

Mean thickness of tunica media in 100 times magnified photomicrograph of left coronary artery was 32mm. (Fig. 1) while the mean thickness of tunica media in 100 times magnified photomicrograph of right coronary artery was 8mm. (Fig. 2). Therefore after dividing above mentioned mean thickness by 100 the actual mean thickness of tunica media in case of left coronary artery was obtained 0.32mm. while in case of right coronary artery it was obtained 0.08mm. (Table-1) showing the ratio of 4:1 which was present not only between their pulsatory powers i.e. 640 Joule per heart beat in left coronary artery and 160 Joule per heart beat in right coronary artery (Table-1 & 2) but also between their pulse pressures of blood i.e. 64mm. of Hg. in left coronary artery and 16mm. of Hg. in right coronary artery (Table-2).

Table-1

Proportion between pulsatory powers/tunica media thickness of coronary arteries in left coronary arterial dominance (LCAD) group.

Arteries	Mean thickness of tunica media	Pulsatory power (Joule per heart beat)
Left coronary artery	0.32mm.	$\frac{2000\times0.32}{1}=640$
Right coronary artery	0.08mm.	$\frac{2000\times0.08}{1}=160$

Table-2

Pulse pressure, pulsatory power and volume of blood entering the lumen of coronary arteries during each heart beat in left coronary arterial dominance (LCAD) group.

Arteries	Volume of blood entering the lumen during each heart beat	Pulse pressure of blood (mm of Hg)	Pulsatory power
Left coronary artery	10ml.	$\frac{640}{10}=64$	1064=640 Joule per heart beat
Right coronary artery	10ml.	$\frac{160}{10}=16$	1016=160 Joule per heart beat

The mean lumen circumference of lumen of left coronary artery was

equal to that of right coronary artery i.e. 10mm. which equals with the 10ml. volume of blood entering the lumen of left coronary artery as well as right coronary artery during each heart beat (Table-3).

Table-3
Lumen circumference and volume of blood entering the lumen of coronary arteries during each heart beat in left coronary arterial dominance (LCAD) group.

Arteries	Mean circumference of lumen	Volume of blood entering the lumen during each heart beat
Left coronary artery	10mm.	10ml.
Right coronary artery	10mm.	10ml.

Right coronary arterial dominance (RCAD) group
Mean thickness of tunica media in 100 times magnified photomicrograph of left coronary artery was 30mm (Fig. 3) while the mean thickness of tunica media in 100 times magnified photomicrograph of right coronary artery was 10mm (Fig. 4). Therefore after dividing above mentioned mean thicknesses by 100 the actual mean thickness of tunica media in case of left coronary artery was obtained 0.3mm. while in case of right coronary artery it was obtained 0.1mm. (Table-4) showing the ratio of 3:1 which was present not only between their pulsatory powers i.e. 600 Joule per heart beat in right coronary artery (Table-4 and 5) but also between their pulse pressure of blood i.e. 60mm. of Hg. in left coronary artery and 20mm. of Hg. in right coronary artery (Table-5).

Table-4
Proportion between pulsatory power/tunica media thickness of coronary arteries in right coronary arterial dominance (RCAD) group.

Arteries	Mean thickness of tunica media	Pulsatory power (Joule per heart beat)
Left coronary artery	0.3mm.	$\frac{2000\times0.3}{1}=600$
Right coronary artery	0.1mm.	$\frac{2000\times0.1}{1}=200$

Table-5
Pulse pressure, pulsatory power and volume of blood entering the lumen of coronary arteries during each heart beat in right coronary arterial dominance (RCAD) group.

Arteries	Volume of blood entering the lumen during each heart beat	Pulse pressure of blood (mm of Hg)	Pulsatory power
Left coronary artery	10ml.	$\frac{600}{10}=60$	1060=600 Joule per heart beat
Right coronary artery	10ml.	$\frac{200}{10}=20$	1020=200 Joule per heart beat

The mean lumen circumference of left coronary artery was equal to that of right coronary artery i.e. 10mm which equals with 10ml. volume of blood entering the lumen of left coronary artery as well as right coronary artery during each heart beat (Table-6)

Table-6
Circumference of lumen and volume of blood entering the lumen of coronary arteries during each heart beat in right coronary arterial dominance (RCAD) group.

Arteries	Mean Circumference of lumen	Volume of blood entering the lumen during each heart beat
Left coronary artery	10mm	10ml
Right coronary artery	10mm	10ml

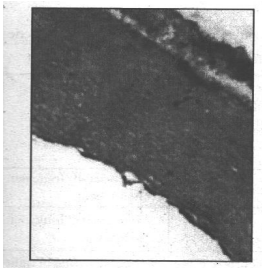
Fig-1 (Transverse section of left coronary artery of human heart with left coronary arterial dominance (PAS X 100)

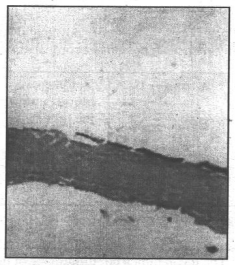
Fig-2 (Transverse section of right coronary artery of human heart with left coronary arterial dominance (PAS X 100)

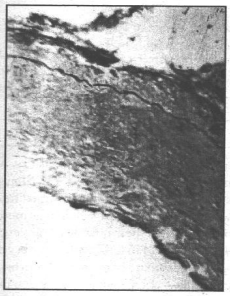
Fig-3 (Transverse section of left coronary artery of human heart with right coronary arterial dominance (orcein X 100)

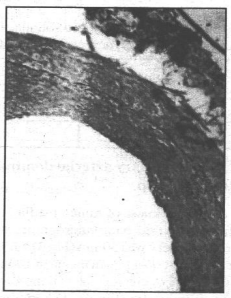
Fig-4 (Transverse section of right coronary artery of human heart with right coronary arterial dominance (orcein X 100)

DISCUSSION
In right coronary arterial dominance during systole of heart thrice more thicker left ventricular wall (myocardium) in comparison to right ventricular wall (myocardium) is responsible for thrice more pulse pressure of blood in left coronary artery in comparison to pulse pressure of blood in right coronary artery. Thrice more wall (tunica media) thickness of left coronary artery in comparison to wall (tunica media) thickness of right coronary artery is due to thrice more pulsatory power of left coronary artery in comparison to pulsatory power of right coronary artery (Keshaw Kumar 2003, 2015)[10,12].

In left coronary arterial dominance the left coronary artery has to supply entire interventricular septum of heart instead of only its anterior 2/3 part as in right coronary arterial dominance therefore left coronary arterial pulse pressure is 64mm of Hg. and pulsatory power is 640 Joule per heart beat instead of 600 Joule per heart beat pulsatory power and and 60mm of Hg. pulse pressure as observed in right coronary arterial dominance. (Keshaw Kumar, 2008, 2016)[13,14].

In right coronary arterial dominance right coronary artery has to supply posterior 1/3 of the interventricular septum of heart while in left coronary arterial dominance right coronary does not supply the inverntricular septum of heart at all. This is the reason that in left coronary arterial dominance right coronary arterial pulse pressure is 16mm of Hg. and pulsatory power is 160 Joule per heart beat instead of 20mm of Hg. pulse pressure and 200 Joule per heart beat pulsatory power of right coronary artery observed in right coronary arterial dominance (Keshaw Kumar 2003, 2015)[10,12].

However blood volume entering the lumen of right coronary and left coronary artery does not vary in right coronary arterial dominance and left coronary arterial dominance and it remains same for both the coronary arteries in both type of coronary arterial patterns i.e. 10ml. during each heart beat.

Therefore ratio between volume of blood entering the lumen of left coronary artery and right coronary artery during each heart beat remains same in both type of coronary arterial patterns i.e. 1:1. In this way "Keshaw Constants" does not vary or alter and remains same i.e. 1:1 in both type of coronary arterial patterns as far as volume of blood entering the lumen of both the coronary arteries during each heart beat is concerned (Keshaw Kumar 2015)[15].

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In the present study in right coronary arterial dominance ratio between pulse pressures of left and right coronary artery resembles with the ratio between pulsatory powers of left and right coronary artery i.e. 3:1 (Keshaw Constants) is similar as reported by Keshaw Kumar (2003, 2015, 2015)[10,12,15] but in case of left coronary arterial dominance the ratio between pulse pressures of left and right coronary arteries is observed 4:1 which resembles with the ratio between pulsatory powers of left and right coronary arteries which is a deviation or alternation of 'Keshaw Constants' being indication of coronary inefficiency or coronary heart diseases as reported by Keshaw Kumar (2003, 2015, 2015)[10,12,15].

Right coronary arterial dominance is a normal coronary arterial pattern because there is no deviation or alternation in the 'Keshaw Constants' (3:1 and 1:1) while left coronary arterial dominance is an abnormal coronary arterial pattern due to deviation/alteration in 'Keshaw Constants' in the form of ratios (4:1 and 1:1) Keshaw Kumar (2008, 2015)[13,15] observed that right coronary arterial dominance exists in 83% population and left coronary arterial pattern exists in 16% population. Therefore 16% population of society is vulnerable for coronary heart disease. 64mm of Hg. pulse pressure in left coronary artery in left coronary arterial dominance and 60mm of Hg. pulse pressure in left coronary artery in right coronary arterial dominance observed in the present study is the answer of as yet unanswered question that why there is increased incidence of coronary heart disease in the persons with left coronary arterial dominance as reported by Blumgart et.al (1940)[3], White (1951)[4], Mathur (1957)[5] and Allwork (1987)[6] because pulse pressure in an artery is directly proportional to tunica intimal density of lipid in that artery (Keshaw Kumar 1996, 2003)[9,11].

On the basis of findings observed in the present study following results are concluded as laws of coronary arterial pulse pressure in left and right coronary arterial dominance.

1. Right coronary arterial pulse pressure is 20mm of Hg. and left coronary arterial pressure is 60mm of Hg. in persons with right coronary arterial dominance.

2. Right coronary arterial pulse pressure is 16mm of Hg. and left coronary arterial pulse pressure is 64mm of Hg. in persons with left coronary arterial dominance.

3. Ratio between left and right coronary arterial pulse pressure is 3:1 in persons with right coronary dominance while ratio between left and right coronary arterial pulse pressure is 4:1 in persons with left coronary arterial dominance.

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