Original Research Paper

Volume : 5 | Issue : 11 | November 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Coronary Arteries of Mammals

Medical Science

KEYWORDS :Circumflex branch, Interventricular branch, Crux of heart, Apical notch, Dominance, Coronary artery

Dr. Keshaw Kumar

Department of Anatomy, Government Allopathic Medical College Banda (U.P.) India

ABSTRACT

Hearts of human, buffalo, pig, goat, dog, rabbit and rat (100 of each) were procured from various sources and preserved in 10% formalin. These mammals represented the different orders of class mammalia. Coronary arteries were dissected in each heart. Gross study of the coronary arteries was made to observe commencement, course, termination and dominance. In pig, rabbit and rat right coronary artery was predominating while in goat and dog left coronary artery predominance was seen. In rabbit, ventral interventricular artery, in goat, dorsal interventricular artery and in rat, both the interventricular arteries were absent. Only in 17 out of 100 human hearts and in 33 out of 100 buffalo hearts the left coronary artery predominance was observed. In rest of the human and buffalo hearts right coronary artery predominance was noticed. In goat circumflex arteries deviated inferiorly from coronary sulcus and descending ventricular branch of left circumflex artery replaced dorsal interventricular branch of right circumflex artery. In rat the main trunks of the right and left coronary arteries replaced their circumflex branches and deviated from coronary sulcus to run towards the apex. Dominant coronary artery not only crossed the crux of heart but also gave posterior interventricular and nodal arteries in all the mammals.

Introduction

In the past gross anatomy of coronary arteries was studied by various workers e.g., Grant and Regnier (1926)[1], Schlesinger (1940)[2], Kazzaz and Shanklin (1950)[3], Ayer and Rao (1958)[4], Jain and Hazary (1958)[5], James (1961)[6], Truex (1963)[7], Ahmed et. al. (1972)[8], Omar (1977)[9] and Allwork (1980, 1986, 1987)[10,11,12].

Keshaw Kumar (1990)[13] described comparative anatomy of coronary arteries in mammals. Keshaw Kumar (2015, 2015)[14,15] discovered a new coronary arterial pattern and created laws of impossibility of codominance or balanced coronary arterial pattern.

Coronary artery giving posterior interventricular branch always crossed the crux of heart and was dominant (Keshaw Kumar, 1978)[16]. Later on in 1980 this criteria was supported by Allwork who described dominant coronary artery was that which gave posterior interventricular artery.

Gross anatomy of coronary arteries belonging to different orders of class mammalia is not documented in detail therefore, the present study was conducted to compare the coronary artery dominance and commencement, course, termination of coronary arteries and their branches in seven different mammals.

Material and methods

Heart specimens of human, buffalo, pig, goat, dog, rabbit and rat (100 of each) were procured from various sources and preserved in 10% formalin. All these mammals belonged to following orders of class mammalia:-

1. Lagomorpha (rabbit)
2. Rodentia (rat)
3. Carnivora (dog)
4. Primate (human)
5. Artiodactyla (buffalo, pig & goat)

Coronary arteries were dissected taking the help of magnifying lens and dissecting microscope to observe gross anatomy of coronary arteries and coronary arterial patterns according to the criteria that coronary artery giving posterior interventricular branch was dominant (Keshaw Kumar, 1978)[16], Allwork, 1980)[10].

Observations

Commencement

In all the mammals left coronary artery commenced from left posterior aortic sinus. Its circumflex branch arose from it near its ostium in human, goat and dog (figures 1, 7, 9). In buffalo circumflex branch of left coronary artery mostly arose from the left posterior aortic sinus with the ventral interventricular branch (figure 3). In pig circumflex branch of the left coronary artery arose form it 1/2 cm distal to its ostium (figure 5). In rabbit and rat left coronary artery replaced its circumflex branch (figure 11), because ventral interventricular branch was absent in these mammals.

Circumflex branch of right coronary artery was the main trunk of right coronary artery which commenced from the anterior aortic sinus in all the mammals.

Anterior interventricular branch commenced from left coronary artery near its ostium in human, goat and dog (figures 1, 7, 9). In buffalo it mostly arose from the left posterior aortic sinus with left coronary artery (figure 3). In pig it arose from the left coronary artery 1/2 cm distal to its ostium (figure 5). It was however absent in rabbit and rat (figure 11).

Posterior interventricular branch commenced from the right coronary artery at the crux in human (83%), buffalo (67%) and pig (100%) (figure 2, 4, 6). It was absent in goat, rabbit and rat (figure 8, 12). While in dog it always commenced from the left coronary artery at the crux (figure 10).

Nodal branch always commenced in these mammals at the crux from the circumflex branch of that coronary artery which crossed the crux and was dominant.

Course

In human, buffalo, pig, dog and rabbit (figure 1, 3, 5, 9, 11) the curcumflex branch of right coronary artery coursed towards the right between the pulmonary trunk and the right auricle. Running in coronary sulcus at the right border of the heart it turned dorsally to reach the crux (figures 2, 4, 6, 10, 12). In goat it passed obliquely over the ventral surface of conus and right ventricle to reach the acute right margin of the right ventricle about half way between the coronary sulcus and and the apex and did not follow the coronary sulcus in any part of its course (figures 7, 8). In rat right coronary artery instead of forming a circumflex branch passed over the right ventricle and continued ventrally in a posterolateral direction to the apex of heart.

Circumflex branch of left coronary artery in human, buffalo, pig and dog (figures 1, 3, 5, 9) coursed ventrally and to the left between pulmonary trunk and left auricle in the coronary sulcus and passed dorsally round the left margin of heart towards the crux. In goat however it immediately left the coronary sulcus to pass nearly 1cm. inferior and parallel to it giving ascending and descending ventricular branches and the main trunk entered the upper part of dorsal interventricular sulcus dividing into a small ascending and a large descending branch (figures 7, 8). In case of rabbit, left coronary artery passed a short distance laterally and divided into septal, left marginal and left circumflex branches and did not give interventricular branch (figure 11). In rat, left coronary artery in place of left circumflex branch, coursed around the left side of pulmonary trunk and passed ventrally to the apex parallel to the ventral interventricular sulcus.

In rabbit, ventral interventricular branch (figure 11), in goat, dorsal interventricular branch (figure 8) and in rat, both the interventricular branches were absent. Ventral interventricular branch was occupying ventral interventricular sulcus and the dorsal interventricular branch was found in dorsal interventricular sulcus towards the apex in all the mammals. In goat, descending branch of left circumflex occupied lower part of dorsal interventricular sulcus inplace of dorsal interventricular branch (figure 7, 8). In human, buffalo, pig and goat ventral interventricular branch crossed the apical notch to reach the dorsal interventricular sulcus while in dog ventral interventricular branch reached only upto the apical notch (figure 1, 2, 3, 4, 5, 6, 7, 8, 9, 10). Nodal branch travelled along the upper border of interventricular septum from crux to the atrioventricular node.

Termination

Circumflex branches of the left and right coronary arteries terminated by anastomosing with each other on the left side of the crux of heart in rabbit and pig (figure 6, 12) while in dog and goat these terminated by anastomosing with each other on the right side of the crux of heart (figure 8, 10). In 17 out of 100 hearts of human and 33 out of 100 heart of buffalo right and left circumflex branches terminated by anastomosing with each other on the right side of the crux of heart. In rest of the human and buffalo hearts circumflex branches terminated by anastomosing with each other on the left side of the crux of heart (figures 2, 4). In rat in place of left and right circumflex branches the trunks of left and right coronary arteries terminated by anastomosing with each other at the apex of heart.

In the human heart both the interventricular branches of coronary arteries terminated by anastomosing with each other at the junction of posterior 2/3 and anterior 1/3 of posterior interventricular sulcus (figure 2). In buffalo, pig and goat these terminated by anastomosing with each other in the ventral 1/3 of dorsal interventricular sulcus (figure 4, 6, 8). In goat descending ventricular branch of left coronary artery was present in place of dorsal interventricular branch (figure 8). In dog both interventricular branches anastomosed with each other at the apex of heart (figure 9). Nodal branch terminated by supplying atrioventricular node.

Dominance

Right coronary artery dominance was observed in rat, rabbit and pig while dog and goat showed left coronary artery dominance. Only in 17 out of 100 human hearts and only in 33 out of 100 buffalo hearts left coronary artery dominance was seen. In rest of the human and buffalo hearts right coronary artery dominance was observed (Table 1). In all the mammals it was observed that the coronary artery giving posterior interventricular branch always crossed the crux of heart and hence it was dominant. It was also observed that the dominant artery not only gave the posterior interventricular branch but also the nodal branch to supply the atrioventricular node.

Table-1 :
Percentage of Coronary Artery dominance in Mammals

Mammals	Right Coronary artery dominance	Left Coronary artery dominance
Human	83%	17%
Buffalo	67%	33%
Pig	100%	Nil
Goat	Nil	100%
Dog	Nil	100%
Rabbit	100%	Nil
Rat	100%	Nil

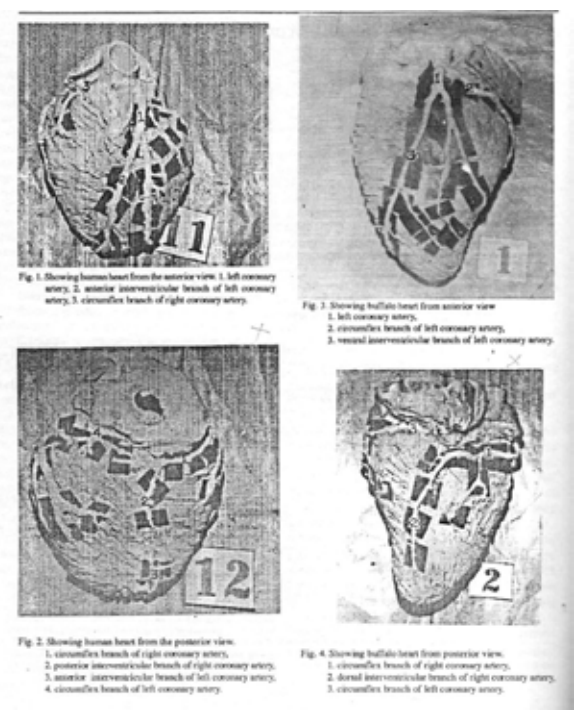

Fig. 1. Showing human heart from the anterior view. 1. left coronary artery, 2. anterior interventricular branch of left coronary artery, 3. circumflex branch of right coronary artery.

Fig. 3. Showing buffalo heart from anterior view 1. left coronary artery, 2. circumflex branch of left coronary artery, 3. ventral interventricular branch of left coronary artery.

Fig. 2. Showing human heart from the posterior view. 1. circumflex branch of right coronary artery, 2. posterior interventricular branch of right coronary artery, 3. anterior interventricular branch of left coronary artery, 4. circumflex branch of left coronary artery.

Fig. 4. Showing buffalo heart from posterior view. 1. circumflex branch of right coronary artery, 2. dorsal interventricular branch of right coronary artery, 3. circumflex branch of left coronary artery.

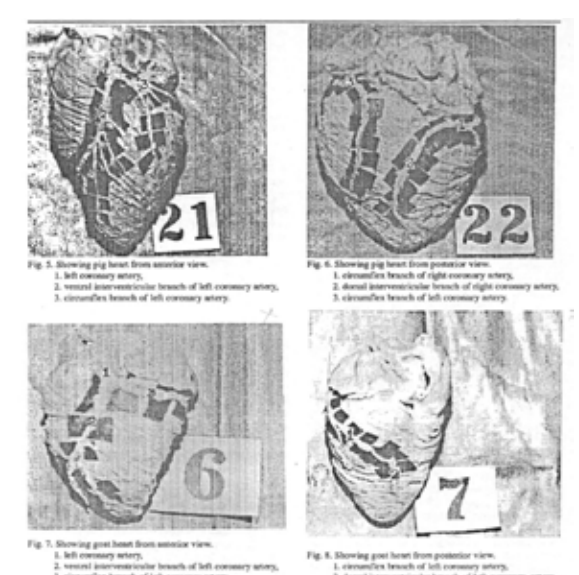

Fig. 5. Showing pig heart from anterior view. 1. left coronary artery, 2. ventral interventricular branch of left coronary artery, 3. circumflex branch of left coronary artery.

Fig. 6. Showing pig heart from posterior view. 1. circumflex branch of right coronary artery, 2. dorsal interventricular branch of right coronary artery, 3. circumflex branch of left coronary artery.

Fig. 7. Showing goat heart from anterior view. 1. left coronary artery, 2. ventral interventricular branch of left coronary artery, 3. circumflex branch of left coronary artery.

Fig. 8. Showing goat heart from posterior view. 1. circumflex branch of left coronary artery, 2. dorsal interventricular branch of left coronary artery.

Volume : 5 | Issue : 11 | November 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Fig. 9. Showing dog heart from anterior view.
1. left coronary artery,
2. ventral interventricular branch of left coronary artery,
3. circumflex branch of left coronary artery.

Fig. 10. Showing dog heart from posterior view.
1. circumflex branch of right coronary artery,
2. circumflex branch of left coronary artery,
3. dorsal interventricular branch of left coronary artery.

Fig. 11. Showing rabbit heart from anterior view.
1. circumflex branch of left coronary artery,
2. ventral interventricular sulcus showing absence of ventral interventricular branch of left coronary artery.

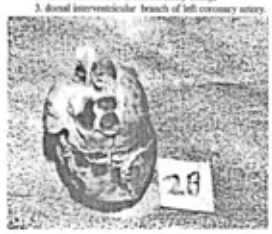

Fig. 12. Showing rabbit heart from posterior view.
1. circumflex branch of right coronary artery,
2. dorsal interventricular branch of right coronary artery,
3. circumflex branch of left coronary artery.

Discussion

Findings in the present study resemble with findings of Keshaw Kumar (1990)[13].

In the present study the of incidence of the two different types of the coronary arterial patterns in human has been observed to vary considerably from that earlier reported (figures 1, 2). The incidence of pattern showing predominance of left coronary artery was 17% in human, in the present series, as compared to 10% reported by Jain & Hazary (1958)[5], 28% by Ayer and Rao (1957)[17], and 18% by Schlesinger (1940)[2]. This could be the result of racial or perhaps geographical variation. In their study of pathological hearts Blumgart et. al. (1940)[23] have correlated the incidence of coronary artery thrombosis and angina pectoris with the type of arterial patterns. They concluded that in hearts showing left coronary artery predominance the incidence of the coronary disease was much prevalent. Similar findings have also been given by White (1951)[18], Mathur (1957)[19], Allwork (1986, 1987). [11,12]Keshaw Kumar (2015)[24] established that devitation/alteration of "Keshaw Constants" in coronary arteries was the exact cause of increased incidence of coronary heart disease in persons with left coronary arterial dominance.

Ahmed (1972)[8] reported the coronary anastomoses in 73.4% cases thus giving an accurate evaluation of coronary artery preponderance. Omar (1977)[9] confirmed that majority of human hearts have left coronary artery predominance. The findings of left coronary artery predominance and arterial pattern in the dog (figure 9, 10) in the present work corroborates with the work of various authors (Moore, 1930)[20] (Pianetto, 1939)[21], (Kazzaz and Shanklin, 1950)[3], (Jain and Hazary, 1958)[5], (Ayer and Rao, 1958).[4]

Jain and Hazary (1958)[5] reported that in the dog, sheep, goat and buffalo the pattern of coronary arteries was fixed and it resembled more with human pattern where the left coronary artery predominated and supplied the whole of the interventricular septum. In the present study, the coronary arterial pattern in the dog, goat and buffalo resembled with the findings of Jain and Hazry (1958)[5] except that the left coronary artery predominance was seen only in 33 out of the 100 hearts of buffalo where the circumflex branch of the left coronary artery continued as dorsal interventricular branch in the dorsal interventricular sulcus. In rest of the 67 hearts of buffalo the dorsal interventricular branch was continuation of right coronary artery in the dorsal interventricular sulcus (figure 4, 8, 10).

In case of rabbit, the right coronary artery predominance was observed in all the 100 hearts studied and the ventral interventricular branch was absent through out (figures 11, 12). These findings resemble with the findings of Ayer and Rao (1958)[4].

Coronary arterial pattern of rat heart observed in the present study resembles with the findings of Halpern (1957)[22] where right coronary artery predominates. In the pig the coronary arterial pattern is fixed and resembles with the human pattern where right coronary artery predominates (figures 5, 6).

References

1. Grant, R.T. and Regnier, M.. The comparative anatomy of the cardiac coronary vessels. *Heart*, (1926)13 : 285-317.
2. Schlesinger, M.J.. Relation of anatomic pattern to pathologic conditions of the coronary arteries, A.M.A., *Arch. Path.* (1940) 30 : 403-415.
3. Kazzaz, D.S. and Shanklin, W.M.. The coronary vessels of the dog demonstrated by colored plastic (Vinyl acetate injections and corrosion). *Anat. Rec.*, (1950)107 : 43-59.
4. Ayer, A.A. and Rao, Y.G.. The coronary arterial pattern in some common laboratory animals - rabbit, dog, cat, *J. Anat. Soc. India*, (1958) 7 : 5.
5. Jain, S.P. and S. Hazary. Coronary arterial pattern in man and some other mammals. *J. Anat. Soc. India*, (1958) 7 : 1.
6. James, T.N. Significant differences between human and canine coronary arteries. *In Anatomy of Coronary arteries,* (1961) p. 162.
7. Truex, A.B.. The distribution of human coronary arteries. *Coronary Heart Disease.* (1963) p. 4.
8. Ahmed M.T.; Rakhawy, E.I.; Abdalla, A.; Soheir, H. and Harrison, R.G.. A new conception of coronary artery preponderance. *Acta Anat.*, (1972) 83 : 160.
9. Omar, B.K. Coronary artery predominance - A new parameter for its study. *J. Anat. Soc. India,* (1977) 26 : 86-90.
10. Allwork, S.P. Angiographic anatomy. *In Cardiac Anatomy* (ed. R.H. Anderson & A.E. Becker). (1980) Ch. 7. London : Churchill Livingstone.
11. Allwork, S.P. The anatomy of the coronary arteries. In the surgery of coronary artery disease, London, Chapman & Hall, (1986) pp. 15-25.
12. Allwork, S.P. The applied anatomy of the arterial blood supply to the heart in man. *J. Anat.,* (1987) 153 : 1-16.
13. Keshaw Kumar. Comparative anatomy of coronary arteries - A gross study in Mammals. Journal of Anatomical Sciences. (1990) Vol. 12 : 45-51.
14. Keshaw Kumar. Great dominance of right coronary artery - Discovery of new coronary arterial pattern. International Journal of Scientific - Research (2015) Vol. 4 (6) : 44-45.
15. Keshaw Kumar. Laws of impossibility of codominance or balanced coronary arterial pattern. International Journal of Scientific Research (2015) Vol. 4 (9) : 49-50.
16. Keshaw Kumar. Histological study of coronary arteries in different mammals. Thesis for M.S. Anatomy. Allahabad University Allahabad (1978).
17. Ayer, A.A. and Rao, Y.G. A radiographic investigation of the coronary arterial pattern in human hearts. *J. Anat. Soc. India*, (1957) 6 : 63-67.
18. White, P. Diseases of the heart and circulation. 2nd ed. London, Eyre & Spottiswoode (1951) p. 727.
19. Mathur, K.S. Coronary arterial diseases. *Proc. Indian Sci. Cong.* Part IV. (1957) 96-103.
20. Moore, R.A. The coronary arteries of the dog. *Amer. Heart. J.* (1930) 5 : 743-749.
21. Pianetto, M.B. The coronary arteries of the of the dog. *Amer. Heart. J.* (1939)18 : 403-410.
22. Halpern, M.H. The dual blood suply of the rat heart, *Am. J. Anat.,* (1957) 101 : 1-16.

23. Blumgart, H.L; Schlesinger, M.J. and Davis, D. Studies on the relation of the clinical manifestations of angina pectoris, coronary thrombosis, and myocardial infraction to the pathologic findings with particular reference to significance of collateral circulation. *Amer. Heart. J.*; (1940) 19 : 1-91.
24. Keshaw kumar. Devitation/alteration of "Keshaw Constants" in coronary arteries is the exact cause of coronary heart disease in persons with left coronary arterial dominance International Journal of Scientific Research (2015) Vol.4 (8): 13-16.