EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

STUDY OF CORONARY DOMINANCE IN THE MOZAMBICAN POPULATION

Mahomed Sidique Abdul Cadar Dadá[1*], Maria Alexandra Rodrigues[1], Abdul Habib Dadá[3], Maria Vitoria Neves[1] and Jahit Sacarlal[2]

[1]Serviço de Anatomia, Faculdade de Medicina, Universidade Eduardo Mondlane.
[2]Faculdade de Medicina, Universidade Eduardo Mondlane.
[3]Dentist student. ISCTEM.

*Corresponding Author: Mahomed Sidique Cadar Dadá

Serviço de Anatomia, Faculdade de Medicina, Universidade Eduardo Mondlane.

ABSTRACT

Introduction: With the emergence of coronary diseases, the interest of anatomists and cardiologists in the anatomical study of coronary arteries has increased. The multiple variations in their pattern of irrigation possibly have impact and an anatomical-clinical correlation between the type of irrigation and the different risks of myocardial infarction. The pattern of coronary artery distribution in the Mozambican population remains unknown since this type of study has not yet been performed. **Objectives:** identify possible patterns of coronary arteries in the Mozambican population. **Metodology**: 30 adult human hearts of both gender, who died from non-cardiovascular causes were study by injection of latex. **Results**: Right predominance was evident in 70% of the cases, balanced in 20% and left in 10%. In 63.3% of the cases the left coronary artery presented a bifurcation in to anterior interventricular and circumflex artery. In 33.3% of the hearts examined, the left coronary artery presented trifurcation in to anterior interventricular, circumflex and lateral branches. The artery of the sinuatrial node arise from right coronary artery in 66.7% of cases and 33.3% from the left coronary artery. The atrioventricular node artery in 93.3% of cases was arise from the right atrioventricular artery and 56.7% of the hearth had no bridges. 40% of the hearts had 1/5 of the posterior face irrigated by the anterior interventricular artery. 30% of the cases presented 6 diagonal branches. **Conclusion**: Coronary artery and its branches present many variations and should be important to do more studies in order

KEYWORDS: Coronary, artery, variation, pattern, Mozambican.

INTRODUCTION

The irrigation of the heart depends on the branches of the coronary arteries, which are usually two, right and left. They are so designated because they outline the base of the ventricle as if it were a crown.[1,2]

In the past century, Vieussens studied the vascularization of the heart.[3] and were continued by other anatomists, but due to the little clinical application of the topic at the time and the religious limitations for studies on the corpse, there was little interest from doctors in promoting this topic.[4]

With the advent of coronary artery diseases and myocardial infarction, the interest of anatomists and cardiologists in the study of heart vascularization and their variations and possible anatomical-clinical correlations between the type of irrigation and the different risks of myocardium infarction has increased.[4,5]

The blood supply of the heart comes from the coronary arteries. The left artery is larger than the right, arise in the coronary ostium of the ascending aorta and pass through the left atrioventricular groove and divides into two branches, anterior interventricular (AIVA) and circumflex trunk,[6] and eventually a third branch may appear, the intermediate artery, forming a trifurcation.[7]

The anterior interventricular artery runs through the entire anterior interventricular sulcus and reaches the tip of the heart, bypassing it and becoming posterior, following the distal part of the posterior interventricular sulcus, where it can join with the posterior interventricular artery (AIVP) and can give posterior septal branches. In its course it gives right ventricular branches and diagonal arteries, which arise from the left side of the heart and distribute in the anterolateral wall of the left ventricle and anterior septal arteries.[6]

The right coronary artery arises in the coronary ostium of the ascending aorta, at the level of the right aortic sinus and runs through the anterior atrioventricular sulcus surrounded by a Cellulo adipose layer to the right edge of the heart, contouring it and going to the posterior face, along the groove of the posterior ventricular atrium, until

reaching the crux cordis, where it makes a right angle and descends through the posterior interventricular groove, changing its name to posterior interventricular artery.[6] There is usually no artery that originates from the posterior aortic sinus.[7]

In the development of acute myocardial ischemia, the clinical picture will depend on the territorial distribution of the affected arteries and the type of treatment depends on the risk that the occlusion of an important artery brings to the patient. The contemporary minimally invasive procedures for the treatment of these vessels require a great anatomical knowledge of coronary arteries.[4]

The relationship between the coronary arteries in the crux cordis (region of confluence of the 3 grooves, atrial, ventricular and atrio-ventricular), determines the coronary dominance, which is given by the artery that emits the posterior interventricular branch. It can be right, left or balanced. The term was proposed by Schlesinger in the last century (1940). Right pattern when the right coronary artery irrigates the posterior face of the right ventricle, giving rise to the posterior interventricular branch and crossing the crux cordis to irrigate a portion of the left ventricle; Mix pattern when the right coronary irrigates the right ventricle and the posterior portion of the interventricular septum through the posterior interventricular branch, while the artery the left coronary artery irrigates the homolateral ventricle ending at the crux cordis. Left pattern when the left coronary irrigates the posterior face of the ipsilateral ventricle, the posterior segment of the interventricular septum and / or the posterior wall of the contralateral ventricle.[4,8]

The ventricular portion vascularized by the left coronary artery is larger, but the right dominance is more frequent, however, the left dominance appears to be related to higher mortality in acute myocardial infarction and a higher occurrence of arteriosclerosis.[4]

Anastomoses between the branches of the coronary arteries are extremely important in situations of acute myocardial ischemia, because they bypass the injured vessel, distributing the blood over the affected muscle. They appear particularly between the branches of the septum, the atrial and arterial cone and their advent is related to the presence of chronic ischemia.[4]

Anatomical variations in the coronary arteries are frequent[4] The presence of a single coronary artery, originating in the aorta, is rare in hearts without congenital malformation (<1%).[2,9] In 4% of people there is a third coronary artery (accessory)[4] or a fourth artery,[2] The excess of arteries is due to the isolated arise in the aorta of certain normal collateral branches of the coronaries.[2]

The most frequent variations are two posterior ventricular arteries, number of lateral branches of the anterior interventricular artery and position of marginal branches (without clinical importance)[4] When myocardial fibers cover parts of the path of an artery, forming tunnels, they are called myocardial bridges[4] and are considered a vascular variation of the heart vessels because they produce an intermittent reduction of the arterial lumen and are related to the spasm of the coronary artery and the genesis of myocardial infarction and coronary insufficiency.[6,10] These bridges are a topic of great discussion in recent research. Their physical characteristics, such as length, thickness and number must be taken into account in the cardiac pathophysiology of some diseases, although it is possible that these bridges do not produce any effect. However, a coronary artery with several bridges can cause a clinical picture of angina or arrhythmias, in situations that demand a high cardiac demand, such as physical exercise and stress.[10]

The pattern of coronary artery distribution in the Mozambican population remains unknown since this type of study has not yet been performed and we hope to help cardiovascular surgeon and cardiologist in this matter.

General Objectives
Study the branching pattern of coronary arteries in the Mozambican population

Specific objectives
1. Describe the branching pattern of the coronary arteries and the extension of the vascularized territory by the anterior interventricular artery on the posterior face
2. Describe the origin of the sinoatrial node artery and the number of diagonal branches
3. Describe the position and number of bridges of the myocardial interventricular arteries

MATERIAL AND METHODS
The study was made with a sample of 30 hearts, of both sexes, aged over 25 years, obtained in the anatomical theater of the Department of Morphological Sciences of the UEM medical school, applying the inclusion (Fresh hearts of adults without cardiovascular pathology or chest trauma) and exclusion criteria (Hearts with traumatic injuries, previous cardiac surgery or scars that suggested myocardial infarction), in order to have a sample as uniform as possible where the anatomopathological changes did not change the normal anatomy.

The hearts were initially injected with latex resin and placed in 5% formaldehyde. A week later they were dissected with tweezers and curved Mayo Stille scissors and sometimes with the help of a magnifying glass. The measurements of length and width were carried out with

the use of a minimum graduation of one millimeter. The values obtained were organized in an SPSS spreadsheet.

RESULTS
Pattern of Coronary Artery Distribution
Coronary dominance was given by the coronary artery that provided the posterior interventricular branch. Right predominance was evident in 70% (21/30) of the cases, balanced in 20% (6/30) and left in 10% (3/30)

Table 1: Pattern of coronary artery.

Pattern	Frequency	Percent
Right	21	70.0
Left	3	10.0
Mix	6	20.0
Total	30	100.0

Ramification of The Left Coronary Artery
Of the 30 hearts studied, 19 (63.3%) had a bifurcation in the circumflex and anterior interventricular arteries (Fig. 1).

Table 2: Division left coronary artery.

Division left coronary artery	Frequency	Percent
Bifurcation	19	63.3
Trifurcation	10	33.3
Quadrifurcation	1	3.3
Total	30	100.0

Fig. 1: Anterior Interventricular artery.

Origin of Nodal Arteries
The sinuatrial node artery in 66.7% of the hearts (20/30) arise from right coronary artery and in 33.3% of the hearts (10/30) it originated in the circumflex artery.

Table 3: Origin of sinoatrial nodal artery.

Origin of sinoatrial nodal artery	Frequency	Percent
Circunflex artery	10	33.3
Right Coronary artery	20	66.7
Total	30	100.0

In 93.3% of cases (28/30), the artery of the atrioventricular node arises from the right coronary artery and in 6.7% of cases (2/30) it arises from the circumflex artery.

Table 4: Origin of atrioventricular nodal artery.

Origin of atrioventricular nodal artery	Frequency	Percent
Right Coronary artery	28	93.3
Circunflex artery	2	6.7
Total	30	100.0

Myocardial Bridges
More than half of the hearts studied (56.7%, 17/30) did not have myocardial bridges; 36.7% (11/30) of the hearts studied had only one bridge; 6.7% (2/30) of the hearts had two bridges. The length of the bridges varied from 0.5 to 6.3 cm. There was a greater number of bridges in cases of right distribution (Fig. 2)

Table 5: Number of myocardial bridges observed.

Number bridges	Frequency	Percent
0	17	56.7
1	11	36.7
2	2	6.7
Total	30	100.0

Of the 13 myocardial bridges observed, 92.3% were located in the anterior interventricular artery and 7.7 in the 2 arteries (anterior interventricular artery- AIVA and posterior interventricular artery -AIVP).

6.7% (2/30) of the hearts had two bridges located in the anterior and posterior interventricular artery All bridges were located in the anterior interventricular artery, except for one case that was located in the posterior interventricular artery
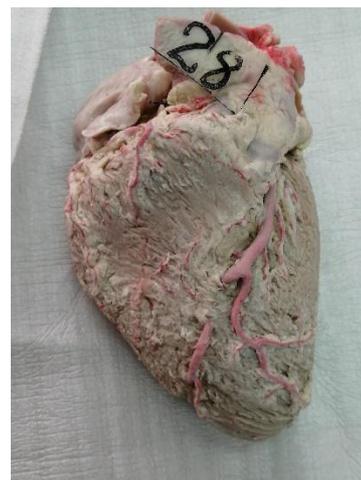

Fig. 2: Myocardial bridge.

Table 6: Distribution of myocardial bridges by AIVA and AIVP.

Number of bridges	Brigdes position in miocardium		Total
	AIVA	AIVA e AIVP	
1	11 (91.7%)	0 0.0%	11 (84.6%)
2	1 (8.3%)	1 (100%)	2 (15.4%)
	12 (100%)	1 (100%)	13 (100%)

Diagonal Branches
Nine of the 30 hearts (30%) had 6 diagonal branches in the anterior interventricular artery and 20% (6/30) had 5 diagonal branches.

Table 7: Number of diagonal branches.

Number of diagonal branches	Frequency	Percent
3	4	13.3
4	2	6.7
5	6	20.0
6	9	30.0
7	5	16.7
8	3	10.0
9	1	3.3
Total	30	100.0

As can be seen in Table 8, more than 40% of the hearts studied had the first diagonal branch with a greater caliber than any of the others, although it is not related to the number of branches.

Table 8: Frequency of the largest caliber diagonal branches.

Position of the largest caliber diagonal branch	Frequency	Percent
1	13	43.3
2	7	23.3
3	8	26.7
6	1	3.3
9	1	3.3
Total	30	100

Recurrence of The Anterior Interventricular Artery In The Posterior Face
Forty percent of the hearts (12/30) had 1/5 of the posterior face irrigated by the anterior interventricular artery (AIVA).

Table 9: Territory irrigated by the anterior interventricular artery on the posterior face.

Territory irrigated	Frequency	Percent
1/10	11	36.7
1/5	12	40
1/3	6	20
3/4	1	3.3
Total	30	100

Third Coronary Artery
This study found no more than two coronary arteries.

DISCUSSION
The anatomical knowledge of the variations in the coronary branching pattern is important for the understanding of clinical events that occur in the heart, for the performance and correct interpretation of exams and for the surgical approach of patients [11–13] because all myocardial revascularization surgeries and choice of therapy depends on the origin, number of branches, location, area of distribution of coronary arteries.[12,13]

In recent times, coronary arteries have been extensively studied for angiography, and numerous cases of anomalies have been reported. Anomalies can be classified: 1. Presence of accessory branches of the aorta and less origin deviation, 2. Presence of a single coronary ostium, 3. Origin from the pulmonary trunk, 4. Anastomoses with other arteries and 5. Variability of the posterior interventricular artery.[9]

Dominance pattern
Table 10: Distribution of dominance patterns from different studies.

Author	Countrys	Year	Right pattern (%)	Left pattern (%)	Mix pattern(%)
Prafulla[14]	India (Maharashtra)	2016	88	10	2
Pussala[15]	India (Telangana)	2017	70	15	15
Kiran[16]	India (Maharashtra)	2018	77.33	18.67	4
Bharambe Vaishali[17]	India		78	12	10
Das[18]	India (Assam)	2010	70	18.57	11.43
Reddy[19]	India (Andhra Pradesh)	2017	65	25	10
Ravi[19]	India (Karnataka)	2017	83.3	13.3	3.33
Abuchaim[4]	Brazil (Parana)	2000	72	20	8
Ballesteros Acuna[8]	Colombia	2007	83.7	7.1	9.2
Balleteros Acuna[10]	Colombia	2008	76	7.8	16.2
Moore[1]		1994	50	20	30
Our study	Mozambique	2020	70	10	20

Dominance can be right, left or mixed,[4] As you can see in **Table 10**, our study found a right predominance, coinciding with several other studies.[1,4,8,14–20] In our study, no anomaly of the origin of the coronary arteries was found, unlike other studies.[4,20]

Myocardial bridges
Similar to other studies,[10] more than half (53.3%) of the observed hearts did not have myocardial bridges. The maximum number of bridges in our study was 2, while in other series there were up to 4 bridges.[10]

The length of the bridges varied from 0.5 to 6.3 cm. Acuna[11] had a large bridge (19.3 cm)

In our study there was a greater number of bridges in cases of right distribution, whereas in other studies,[10] there was more in the balanced pattern.

Supernumerary coronary arteries
Although our study did not find supernumerary coronary arteries, many studies done worldwide show that it is not uncommon,[10,20,22] There is an association between the presence of myocardial bridges and the number of coronary arteries. The probability of having a third coronary artery is 2.34 times greater in cases of heart with bridges.[10]

The supernumerary right coronary artery is not rare as previously thought. Maric found in 52.7% of the cases.[22]

Table 11: Presence of 3rd coronary artery.

3rd coronary artery	Country	%
Ravi[20]	India (Karnataka)	26.6
Kalpana[21]	India (Thanjavur)	24
Maric[22]	Servia	10.9
Bellasteros Acuna[10]	Colombia	29.8
Our study	Moçambique	0

Collateral circulation
Like the study by Brazil,[14] the method used did not allow the identification of collateral circulation between the coronary arteries of the studied parts.

Left coronary artery branching
Of the 30 hearts studied, 21 (70%) had a bifurcation in the circumflex and anterior interventricular arteries. These findings are in line with other studies.[4] Trifurcation seems to provide a way of protecting against ischemia.[13]

Intercoronary Anastomoses
Anastomoses were not observed between the two coronary arteries.

CONCLUSION
1. The right pattern is the most frequent (70%);

2. Most of the hearts (70%) had a left coronary artery bifurcation.
3. In 40% of cases, the anterior interventricular artery had a recurrent path to a distance of about 1/5 of the posterior interventricular groove.
4. The sinuatrial node artery arises from the right coronary artery in 66.7% of cases
5. The artery of the atrioventricular node arises from the right interventricular artery in 90% of cases.
6. 26.7% of the hearts studied presented 5 diagonal branches

REFRERENCES
1. Moore K. Anatomia Orientada para a Clinica. 3rd ed. Editora Guanabara Koogan, 1994.
2. Testut L, Latarjet A. Tratado de Anatomia Humana Tomo II. Barcelona: Salvat editores, 1984.
3. Shane Tubbs R, Shoja MM, Loukas M AP. History of Anatomy: An International Perspective. Wiley

Blackwel, 2019.

4. Abuchaim D. Estudo da anatomia das artérias coronárias humanas [Internet]. Universidade Federal do Paraná, 2000. Available from: acervodigital.ufpr.br/bitstream/handle/1884/36166/R - D - DECIO CAVALET-SOARES ABUCHAIM. pdf? sequence=1&isAllowed=y.

5. Lima Júnior R, Cabral R, Prates N. Tipos de circulação e predominância das artérias coronárias em corações de brasileiros. Rev Bras Cir Cardiovasc [Internet], 1993; 8(1). Available from: https://www.scielo.br/pdf/rbccv/v8n1/v8n1a02.pdf.

6. Mateu D. Estudio de la vascularización de algunos territorios especiales del corazón: Base anatómica para la comprensión de las consecuencias que ocasiona su oclusión. In: Calzada J, editor. Urgencias Médico-Quirurgicas. Barcelona: Facultad de Medicina. Universitat Autónoma de Barcelona, 1986; 37–56.

7. Altin C, Kanyilmaz S, Koc S, Gursoy YC, Bal U, Aydinalp A, et al. Coronary anatomy, anatomic variations and anomalies: A retrospective coronary angiography study. Singapore Med J., 2015; 56(6): 339–45.

8. Ballesteros Acuña LE, Corzo Gómez EG, Saldarriaga Tellez B. Determinación de la Dominancia Coronaria en Población Mestiza Colombiana: Un Estudio Anatómico Directo. Int J Morphol, 2007; 25(3): 483–91.

9. Lippert H PR. Arterial variation in man. Classification and frequency. Hannover, 1985.

10. Ballesteros Acuña LE, Ramírez Aristeguieta LM, Saldarriaga B. Descripción Morfológica e Implicaciones Clínicas de Puentes Miocárdicos : un Estudio Anatómico en Colombianos. Arq Bras Cardiol, 2008; 249–55.

11. Batista A, Porto E, Molina G. Estudo da anatomia da artéria coronária esquerda e suas variações: perspectivas de nova classificação. REV Saude Cienc [Internet], 2011; 2(1): 55–65. Available from: www.ufcg.edu.br/revistasaudeeciencia/index.php/RSC-UFCG/article/viewFile/38/41.

12. Darmender P, Madan S, Anitha T. A Study of Coronary Artery Predominance and Its Clinical Importance. IOSR J Dent Med Sci., 2014; 13(6): 36–8.

13. Abuchaim DCS, Spera CA, Faraco DL, Ribas Filho JM, Malafaia O. Dominância coronariana em corações humanos em moldes por corrosão. Rev Bras Cir Cardiovasc, 2009; 24(4): 514–8.

14. Dakhane Prafulla S, Patil Ashalata D, Nikam Vasudha R, Karmalkar Arun S, Anita Gune R, Pote Anand J. a Study of Coronary Dominance in Preserved Human Cadaveric Heart Specimens in Kolhapur Region of Western Maharastra: a Dissection Method. Int J Anat Res., 2016; 4(3.3): 2842–6.

15. Pusala B, Reddy MV. Termination and Dominance of Coronary Arteries: on Telangana Population. Int J Anat Res., 2017; 5(2.1): 3735–40.

16. Kiran NS, Doshi MA, Devendrappa SN, Saxena S, Sam M. A study on coronary dominance and luminal diameters of major coronary arteries in cadaveric human hearts of the Maharashtra population. Ital J Anat Embryol, 2018; 123(2): 173–8.

17. Bharambe Vaishaly K AVU. A study of coronary dominance. Natl J Basic Med Sci, (3): 178–83.

18. Das H, Das G, Das DC, Talukdar K. Site (i) Right border (ii) Right border – crux (iii) Crux (iv) Crux- left border (v) Left border Total Site Acute / Right Border Crux-acute border Crux Obtuse border – crux Obtuse / left border Total Male Female Total (%) Total (%) Female Domina, 2010; 59(2): 187–91.

19. Reddy DDRK. A Study of Branching Pattern and Distribution of Coronary Arteries in Adult Human Heart. J Med Sci Clin Res, 2017; 5(12): 31603–13.

20. Ravi V, S T. Anatomical Variation in Branching Pattern and Dominance in Coronary Arteries: a Cadaveric Study. Int J Anat Res., 2017; 5(1.3): 3611–7.

21. Kalpana R. A Study On Principal Branches of Coronary Arteries In Humans. J Anat Soc India, 2003; 52(2): 137–40.

22. Maric DL, Colic B, Mirovic M, Eric M, Radosevic D, Knezi N, et al. Prevalence of Third Coronary Artery: Variation or Constant Coronary Artery? Int J Morphol, 2018; 36(4): 1241–5.