International Journal of Anatomy and Research,
Int J Anat Res 2015, Vol 3(3):1362-70. ISSN 2321- 4287
DOI: http://dx.doi.org/10.16965/ijar.2015.238

Original Article

MORPHOMETRIC STUDY OF THE RIGHT CORONARY ARTERY

El Sayed S. Atta-Alla*[1], Ezzat A. El Sawa [2], Ahmed E.S. Atta-Alla[3], Ezdihar A. El Baassiri [4], Khodor Haidar Hassan [5].

*[1] Professor of Anatomy and Embryology, Faculty of Medicine, Beirut Arab University, Lebanon.

[2] Professor of Anatomy and Embryology, Faculty of Medicine, Beirut Arab University, Lebanon.

[3] Medical student, Faculty of Medicine, Alexandria University, Egypt.

[4] Medical student, Faculty of Medicine, Beirut Arab University, Lebanon.

[5] Assistant Professor,Dept. of Physical Therapy, Faculty of Public Health, Lebanese University, Lebanon.

ABSTRACT

Introduction: The anatomy of the coronary arteries is fascinating and most varied. The aim of the present work was to study the gross anatomy of the right coronary artery (RCA) regarding its importance for interventional cardiologists and cardiac surgeons.

Materials and Methods: The material of the present study included 30 preserved hearts obtained from the dissecting rooms of anatomy departments, Faculty of Medicine, Beirut Arab University and Alexandria University.

Results: Present study revealed that the length of the first segment of RCA ranged from 5.7 to 8.0 cm with a mean of 6.3 ± 0.6 cm; Its external diameter ranged from 4.0 mm to 7.0 mm with a mean of 5.1 ± 0.7 mm. The length of the second segment of RCA ranged from 3.4 to 6.0 cm with a mean of 4.9 ± 0.7 cm; Its external diameter ranged from 3.1 mm to 5.6 mm with a mean of 4.3 ± 0.8 mm. The right conus artery was found to arise at a distance 0.5 to 2.4 cm with a mean of 1.5 ± 0.6 cm from the beginning of RCA. At a distance 0.6 cm to 2.6 cm with a mean of 1.6 ± 0.6 cm from its beginning, the RCA was found to give its SAN branch. At a distance 2.7 cm to 5.6 cm with a mean of 4.2 ± 0.8 cm from its beginning, the RCA was found to give its acute marginal branch. Whether it terminated at or beyond the cardiac crux, RCA was found to give origin to the posterior interventricular branch in all specimens. In all specimensthe AVN artery was found to arise from RCA at the region of cardiac crux. Myocardial bridging was recorded in 2 specimens.

Conclusion: This study directs the attention towards the importance of the right coronary artery in the supply of the myocardium and the patterns obtained here may be clinically relevant during percutaneous coronary interventions or surgical revascularization.

KEY WORDS: Right coronary artery, Right conus artery, Posterior descending artery, Acute marginal branch, SAN artery, AVN artery.

Address for Correspondence: Prof. Dr. El Sayed Soliman Atta-Alla, Professor of Anatomy and Embryology, Faculty of Medicine, Beirut Arab University, Lebanon. **E-Mail:** soliman449@yahoo.com

Access this Article online

Quick Response code

DOI: 10.16965/ijar.2015.238

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 09 Aug 2015 Accepted: 27 Aug 2015
Peer Review: 09 Aug 2015 Published (O): 30 Sep 2015
Revised: None Published (P): 30 Sep 2015

INTRODUCTION

The anatomy of the coronary arteries is fascinating and most varied. Nowhere, except perhaps in the brain does the organ function dependent so much from one moment to the other on the integrity and constancy of the blood supply. Yet until recently the coronary anatomy was of interest only to anatomists. Following the

angiographic breakthrough, interest and knowledge grew rapidly; however, no one description is complete or entirely satisfactory [1].

The right coronary artery (RCA) arises from the anterior (right coronary) aortic sinus. It passes at first anteriorly and slightly to the right between the right auricle and the pulmonary trunk. It reaches the atrioventricular groove and descends in this almost vertically to the acute cardiac margin, curving around it into the posterior part of that groove [2].

Anatomically, the right coronary artery is divided into two segments. The first segment extends from its origin to the acute margin of the heart; this segment gives anterior atrial and ventricular rami. The second segment extends from the acute margin of the heart to the crux; it gives 1-3 right posterior ventricular rami. As the right coronary approaches the crux, it gives 1-3 posterior interventricular rami, only one of which occupies the posterior interventricular sulcus to form the so called posterior interventricular artery [3].

Aim of the work: The aim of the present work was to study the morphometric gross anatomy of the right coronary artery regarding its importance for interventional cardiologists and cardiac surgeons when they are thinking of performing angioplasty or bypass surgery.

MATERIALS AND METHODS

The materials of the present study included 30 preserved hearts obtained from the dissecting rooms of anatomy departments, Faculty of Medicine, Beirut Arab University and Alexandria University.

Observed for the fallowing parameters in the specimens: Origin of the right coronary artery (RCA), Length and external diameter of the first segment of RCA, Length and external diameter of the second segment of RCA, Origin of the right conus artery, Origin of the SAN artery, Origin of the acute marginal branch, Origin of the posterior interventricular or posterior descending artery (PDA), Length and external diameter of the PDA, Mode of termination of the RCA, Origin of the AVN artery, Presence or absence of myocardial bridge over the RCA or PDA, Branches of the RCA with special reference to SAN artery.

RESULTS

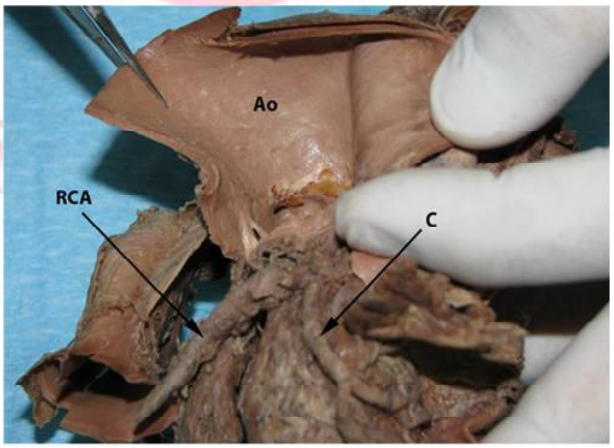
The present study revealed that the RCA was found to arise from the anterior aortic sinus in all specimens; the ostium of the RCA was located in the aortic root just below the sinotubular junction.

The length of the first segment of the RCA ranged from 5.7 to 8.0 cm with a mean of 6.3 ± 0.6 cm; Its external diameter ranged from 4.0 mm to 7.0 mm with a mean of 5.1 ± 0.7 mm.

The length of the second segment of the RCA ranged from 3.4 to 6.0 cm with a mean of 4.9 ± 0.7 cm; Its external diameter ranged from 3.1 mm to 5.6 mm with a mean of 4.3 ± 0.8 mm.

The right conus artery was found to arise at a distance 0.5 to 2.4 cm with a mean of 1.5 ± 0.6 cm from the beginning of RCA. In one specimen(3.3%) the right conus artery was found to arise directly from the anterior aortic sinus (Fig. 1).

Fig. 1: A photograph of the heart showing the right conus branch (C) taking a separate origin from the anterior aortic sinus.



Ao: ascending aorta, RCA: right coronary artery.

At a distance 0.6 cm to 2.6 cm with a mean of 1.6 ± 0.6 cm from its beginning, the RCA was found to give its SAN branch (Fig. 2). This branch ascends upwards between the ascending aorta and right auricle. On reaching the base of superior vena cava, the SAN artery was found to curve posterior to the superior vena cava in 12 specimens (40**%)** (Fig. 3), while it was found to curve anterior to the superior vena cava in 10 specimens (33.3%) (Fig.4). In 8 specimens (26.6 %), SAN artery was found to divide into 2 branches (Fig. 5), one anterior and one posterior to the superior vena cava. In one of the latter

group the SAN artery was large enough (Fig.6) that it divides into an anterior branch and a posterior branch in relation to the superior vena cava as well as an intermediate branch to the wall of the superior vena, then it continues to supply the posterior left atrial myocardium between right and left pulmonary veins.

At a distance 2.7 cm to 5.6 cm with a mean of 4.2 ± 0.8 cm from its beginning, the RCA was found to give its acute marginal branch (Fig. 2). This branch was large enough to reach the cardiac apex in all specimens.

Fig. 2: A photograph of the heart showing RCA passing through the anterior part of the coronary sulcus. It gives right conus artery (C), SAN artery(S), anterior right ventricular branches (R1, R2) and an acute marginal artery (AM).

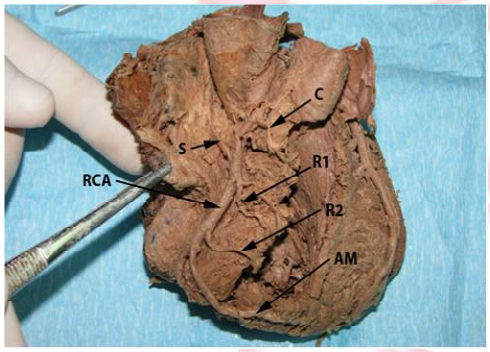


Fig. 3: A photograph of the heart showing the SAN artery (S) taking origin near the beginning of RCA and passing posterior to the opening of superior vena cava(SVC).

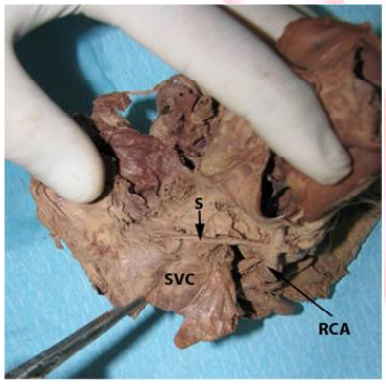


Fig. 4: A photograph of the heart showing SAN artery (S) passing anterior to the superior vena cava(SVC) opening. **RA: right auricle.**

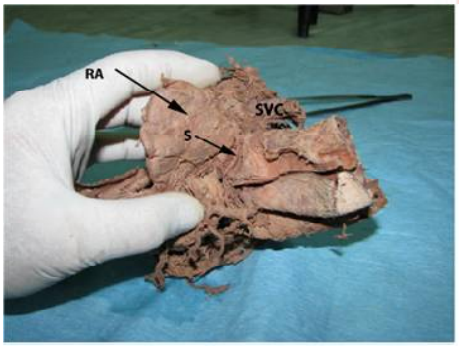


Fig. 5: A photograph of the heart showing the SAN artery (S) giving one right atrial branch (T), one right auricular branch (U), then it divides into two branches one passing anterior(a) to the SVC opening and another passing posterior(P) to the SVC opening.
RCA: right coronary artery.

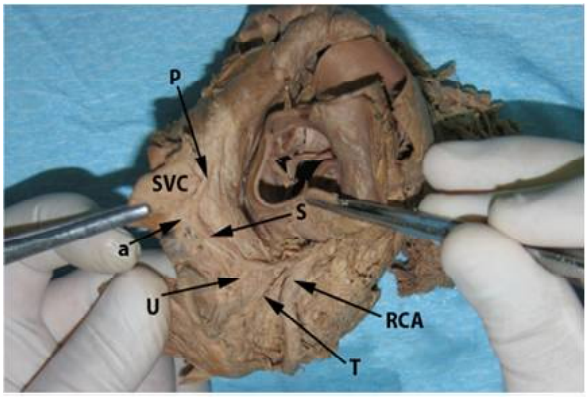


Fig. 6: A photograph of the heart showing the SAN artery giving a branch anterior (a) to the S.V.C. opening, a branch to the wall of S.V.C. (w), another branch passing posterior to the S.V.C. opening (p), then it continues to supply the left atrial myocardium between the two superior pulmonary veins (arrows).

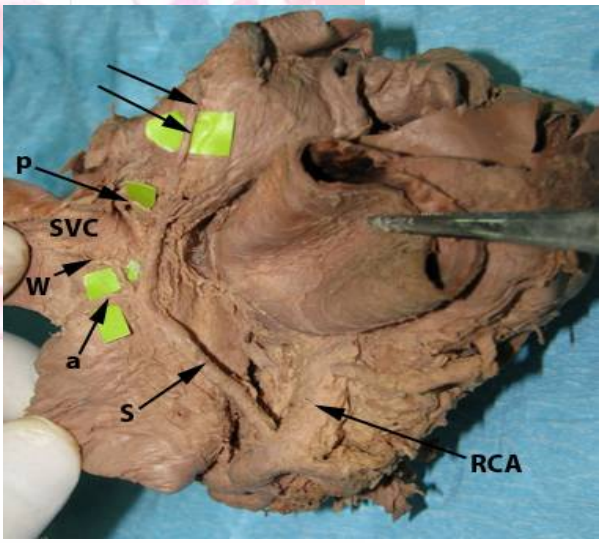
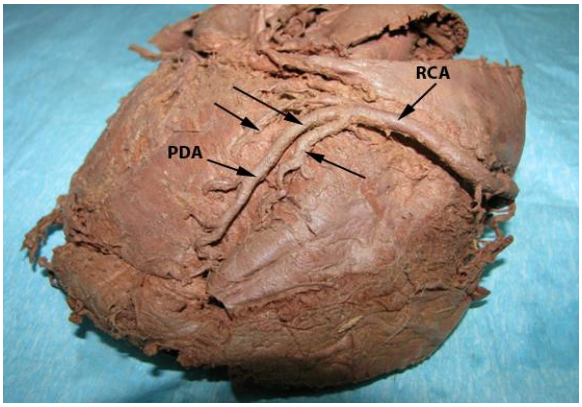


Fig. 7: A photograph of the heart showing the mode of termination of RCA, where it divides into 3 terminal branches (arrows) at the cardiac crux. The middle of which (PDA) occupies the proximal 2/3 of the posterior inter-ventricular sulcus, while the other two branches run parallel to it.



In 12 specimens (40%) the RCA terminated at the cardiac crux (Fig.7) where it gave of its posterior interventricular branch. In 15 specimens (50%), the RCA terminated nearly midway between the cardiac crux and the left border of the heart; while in the other three specimens (10%) the RCA terminated at the left border of the heart (Fig.8).In one of the latter group the RCA continues on the left border of the heart as an obtuse marginal branch (Fig. 9).

Whether it terminated at or beyond the cardiac crux, the RCA was found to give origin to the posterior interventricular branch (PDA) in all specimens (Fig. 7,8,9).

Fig. 8: A photograph of the heart showing RCA giving2 parallel posterior interventricular arteries(R& PDA) then continues beyond the cardiac crux giving two posterior left ventricular branches (L1,L2), then it reaches the left border(star) of the heart.

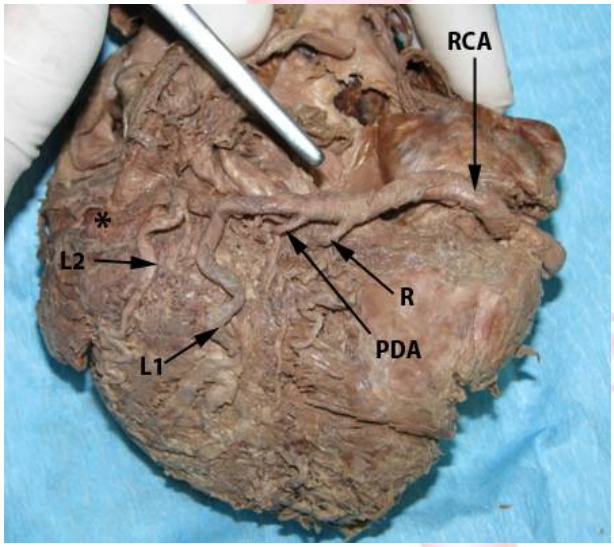


Fig. 9: A photograph of the heart showing RCA giving the posterior interventricular branch (PDA), then it continues beyond the cardiac crux to terminate on the left border of the heart as obtuse marginal branch (OM and arrows).

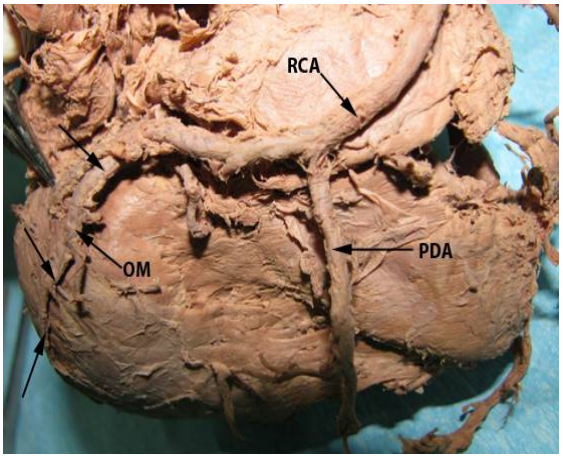


Fig. 10: A photograph of the heart showing RCA giving its posterior interventricular artery (PDA), then it continues beyond the cardiac crux to terminate midway between the crux and the left border of the heart. Here the PDA occupies nearly the proximal half of the posterior inter-ventricular sulcus.LAD is curving around the cardiac apex (arrows)

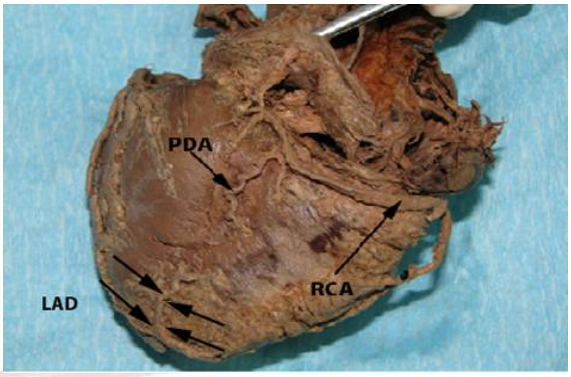


Fig. 11: A photograph of the heart showing RCA giving its posterior inter-ventricular artery (PDA), then it continues beyond the cardiac crux where it gives 3 posterior left ventricular branches (L1,L2,L3); the middle of which soon divides into 2 branches. Here the PDA occupies the proximal 2/3 of the posterior interventricular sulcus.

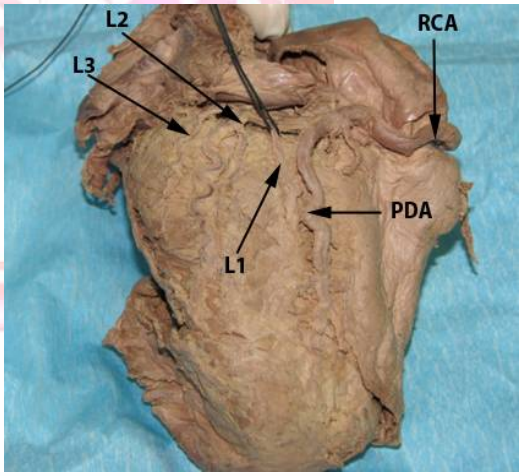


Fig. 12: A photograph of the heart showing RCA giving its posterior inter-ventricular artery (PDA), then it crosses the cardiac crux giving 3 posterior left ventricular branches (L1,L2,L3); the middle of which(L2) soon divides into 2 branches. Note that the PDA continues till the cardiac apex (arrow head). In this specimen the circumflex artery terminates as an obtuse marginal branch (OM).

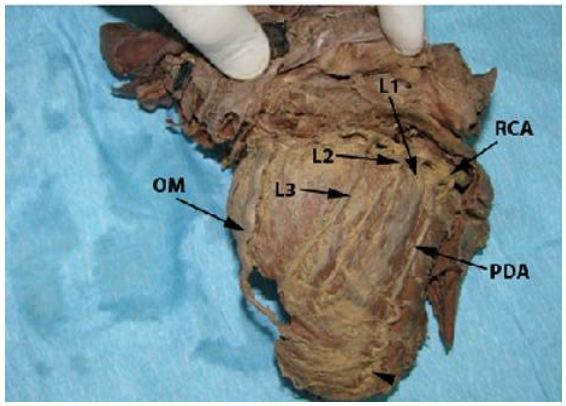


Fig. 13: A photograph of the heart showing the origin of the AVN artery (V) from the terminal part of RCA and passing through the lower part of the inter-atrial septum.

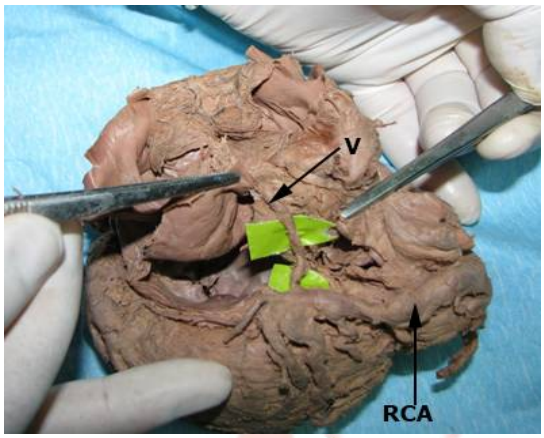


Fig. 14: A photograph of the heart showing the RCA dissected out of its myocardial bridge (arrows).

In 3 specimens (10%), the PDA was found to occupy the proximal half (Fig. 10) of the posterior interventricular sulcus, while in 24 specimens(80%), the PDA was found to occupy the proximal 2/3 (Fig. 11) of the posterior inter-ventricular sulcus. In 3 specimens (10%), the PDA was found to occupy nearly the whole length (Fig. 12) of the posterior interventricular sulcus and reaching the cardiac apex.

The length of the PDA ranged from 4.0 cm to 7.0 cm with a mean of 5.4 ± 1.1 cm; its external diameter at a distance of 1 cm distal to the cardiac crux ranged from 2.3 to 3.9 mm with a mean of 3.3 ± o.4 mm.

The PDA was single in 19 specimens (63.3%); it was accompanied by a parallel branch in 6 specimens (20%); it was accompanied by 2 parallel branches (Fig.7)in 5 specimens (16.7%).

In all specimens the AVN artery was found to arise from RCA at the region of cardiac crux (Fig.13). It passes anteriorly along the upper border of the interventricular septum.

In one specimen, the RCA was covered by a myocardial bridge for a length of about 4 cm (fig.14). This bridge was overlying the distal part of the first segment and the proximal part of the second segment of RCA. In another specimen, the PDA was covered, at its intermediate part by a myocardial bridge for a length of 1.7 cm.

In all specimens, whether it terminated at or beyond the cardiac crux, the RCA was found to give arterial supply to the inferior wall of the left ventricle. One posterolateral branch was present in 7 specimens (23.3%) (Fig. 14); two posterolateral branches were present in 10 specimens (33.3**%);** while three posterolateral branches were present in 13 specimens(43.3%) (Fig.11, 12).

Table 1: Showing summary for the measurements of different parts of the right coronary artery (RCA).

Variable	Mean ± SD
Length of the first segment of RCA	6.3 ± 0.6 cm
Diameter of the first segment RCA	5.1 ± 0.7 mm
Length of the second segment RCA	4.9 ± 0.7 cm
Diameter of the second segment RCA	4.3 ± 0.8 mm
Length of the posterior interventricular artery	5.4 ± 1.1 cm
Diameter of the posterior interventricular artery	3.3 ± 0.4 mm
Distance of origin of the SAN artery	1.6 ± 0.6 cm
Distance of origin of the right conus artery	1.5 ± 0.6 cm
Distance of origin of the acute marginal artery	4.2± 0.8 cm

DISCUSSION

The results of the present study revealed that the ostium of the RCA was located in the middle of the anterior aortic sinus, just below the sinutubular junction in all specimens. Nernatzis and Marionu 2000 [4] reported a high ectopic origin of the coronary arteries and they found that the right coronary artery exhibited a higher frequency than the left one. Piegger et al. 2011 [5] reported an extremely high origin of the RCA 38 mm above the supravalvular crest. On the opposite hand, rare cases had been reported by Angelini 1989 [6] where there were inferiorly situated coronary orifices immediately below the attachment of the aortic valve. These cases were not encountered in the present study.

The present study revealed that the external diameter of the first segment of RCA ranged from

4.0 mm to 7.0 mm with a mean of 5.1 ± 0.7 mm; the external diameter of the second segment of RCA ranged from 3.1 mm to 5.6 mm with a mean of 4.3 ± 0.8 mm; while the external diameter of PDA at a distance of 1 cm distal to the cardiac crux ranged from 2.3 to 3.9 mm with a mean of 3.3 ± o.4 mm.

The present study revealed that the RCA terminated at the cardiac crux in 40% of specimens, while it terminated nearly midway between the cardiac crux and the left border of the heart in 50% and it terminated at the left border of the heart in 10%. Whether it terminates at or beyond the cardiac crux, the RCA was found to give origin to the posterior interventricular branch in all specimens.

Previous investigators reported that the RCA reaches the cardiac crux in about 60% of specimens and terminates a little to the left of this in a variable degree of anastomosis with the circumflex branch of the left coronary artery; in 20% of specimens it reaches the left border of the heart, taking the place of the terminal part of the circumflex artery; in 10% of specimens the right coronary artery ends near the right cardiac margin, while in the remaining 10% the artery ends between this margin and the crux [2]**.** The latter two varieties were not encountered in the present study.

Regarding the length of PDA in the present study; in 10% of specimens, the PDA was found to occupy the proximal half of the posterior interventricular sulcus, while in 80% of specimens, the PDA was found to occupy the proximal 2/3 of the posterior inter-ventricular sulcus. In 10% of specimen, the PDA was found to occupy nearly the whole length of the posterior interventricular sulus and reaching the cardiac apex. The PDA was single in 19 specimens (63.3%); it was accompanied by a parallel branch in 6 specimens (20%); it was accompanied by 2 parallel branches in 5 specimens (16.7%). Nearly similar results were recorded by previous investigators; Busquet et al. 1984 [7] reported that the posterior interventricular artery (PDA) is singular in about 70% of hearts, otherwise being accompanied by parallel branches of the right coronary, which may occur to the right or left of it, or be present on both sides of the sulcus;He also reported that in only 25% of cases does the PDA reach the apex and in another 25%, it reaches only the midpoint between the apex and the base.

The present study revealed that the conus artery originates at a distance of 1.5±0.6 cm from the beginning of RCA. In one specimen (3.3%) the right conus artery was found to arise directly from the anterior aortic sinus. Willerson et al. 1997 [8] reported that the conus branch may arise by a separate origin (in 36% of cases) from the anterior aortic sinus where it is called the third coronary artery. Angelini P 1989 [6] added that if the conus branch is strongly developed it releases ventricular branches which may nourish more than the conal or infundibular myocardium of the outflow tract. The instance of two right conus branches has been described by Koifman et al. 2001 [9].

Regarding the SAN artery, the present study revealed that this artery was found to arise from the first segment of right coronary artery in all specimens; this may be due to the small number of specimens examined. Kyriakidis MK et al. 1983 [10] reported that the SAN branch arises from the right coronary artery in 59% of individuals, from the left circumflex (LCx) in 38% and has a dual supply in the remaining 3%**.** Pejkovic et al. 2008 [11] reported that the SAN artery was most frequently a large atrial branch of the right coronary artery (63%), arising at a mean distance of 1.2 cm (range 0.2 - 2.2 cm) from its beginning; In 37% of cases the SAN artery was a branch of the left coronary artery or one of its branches; The origin of the SAN artery was not related to coronary arterial dominance. Sinoatrial node artery originating from posterolateral branch of RCA is very rare [12]. Ramanathan et al. 2009 [13] reported that the SAN was supplied by the right coronary artery (RCA) in 53% of the cases, by the circumflex (Cx) branch of left coronary artery (LCA) in 42.66%, and by both coronary arteries in 4.33% of cases.

Also in relation to this point, Oztruk et al. 2011 [14] in turkey, through CT angiography reported that the sinoatrial node was being vascularized by a single artery in 96% cases and by two arteries in 4% cases. This artery was arising from RCA in 55.4% of cases, from LCx in 39.4% of cases, from the aorta in 0.8% of cases, and from

the bronchial artery in 0.4% of cases. He also reported that the mean distance between the origin of the SAN artery from RCA and the RCA ostium was 16.2 mm which is consistent with that obtained in the present study. Again in turkey, Cezlan et al. 2012 [15] reported that there was a single SAN artery in 95.7% patients, and two SAN arteries in 4.2% patients. Regarding the first group(single SAN artery), it was found to originate from right coronary artery in 58.2%, from left circumflex (LCx) artery in 37.2%, while one patient had a SAN artery originating from the aorta. In Koreans, Song YS et al. 2012 [16] reported that the SAN was supplied by a single artery in 96.4% of cases and by 2 arteries in 3.6% of cases; The SAN artery originated from the right coronary artery in 53.4% of cases and from the left circumflex in 43% of cases.

The present study revealed that, on reaching the base of the superior vena cava, the SAN artery was found to curve posterior to the superior vena cava in 40% of specimens, while it was found to curve anterior to the superior vena cava in 33% of specimens. In 27% of specimens, SAN artery was found to divide into 2 branches, one anterior and one posterior to the superior vena cava. In one of the latter group the SAN artery was large enough that it divides into an anterior branch and a posterior branch in relation to the superior vena cava; then it continues to supply the posterior area of left atrial myocardium between right and left pulmonary veins. These results are consistent with those reported by Berdajs et al. 2003 [17].

In comparison with the present study Von Lundeghousen 2003 [18] in his study revealed that in 44 % of his cases, the SAN artery courses posterior to the superior vena caval opening, in 40 % of cases the SAN artery courses anterior, while in the remaining cases anterior and posterior branches were present. The SAN branches were found to approach both anterior and posterior in 2-16 % of cases examined by Futami et al. 2003 [19].

In the present study, AVN artery was found to arise from the terminal part of the RCA at the region of the cardiac crux in all specimens. This may be due to the small number of specimens examined. Willerson et al. 1997 [8] reported that AVN artery originated from distal RCA in 87.7% of all patients, and from distal left circumflex artery in 12.3% of all patients. In 80-90 % of cases examined by Arid JM et al. 2000 [20], the AVN artery was found to arise from the terminal part of RCA. The same results were obtained by Futami et al. 2003 [19]. In 15.8 % of cases examined by Sow ML et al. 1996 [21], there was an accessory AVN artery arising from the principal artery in the crux cordis; in 10 % a bilateral artery was present, one from RCA and one from the circumflex artery. Pejkoviæ B 2003 [11] reported that the AVN artery was the first and longest inferior septal perforating branch of the right (90%) or left (10%) coronary artery, arising from the U- or V-shaped segment of the corresponding artery at the level of the crux cordis; here The origin of the AV node artery was dependent on coronary arterial dominance. Ramanathan et al. 2009 [13] in Indians reported that he AV node was also more often supplied by the RCA (72.33% of cases) than by the circumflex branch of the LCA (27.66%), and surprisingly in none of the cases was this node supplied by both coronary arteries.

Identification of the anatomical variants of the arterial blood supply to the SA and AV nodes may help in overcoming potential difficulties in treating arrhythmias and in mitral valve surgery.

Regarding myocardial bridging, the present study revealed the presence of myocardial bridge in two specimens (6.5%); one overlying the right coronary artery for a length of about 4 cm and one overlying the posterior descending artery for a length of about 1.7 cm. Bezerra et al. 1989 [22] reported that the length of the intramural segment ranged from 9 to 69 mm and that the anterior inter-ventricular artery is the most frequently affected. Koifman B et al. 2001 [9] and Berry et al. 2002 [23] stated that compression of the vessel by systolic contraction of the overlying bridge could produce variable degrees of ischemia depending upon the length of the bridge, the thickness of the overlying muscle and the multiplicity of the bridges over single artery. Agribasli et al. 1997 [24] suggested an association between sudden death and vigorous exercise in otherwise healthy young people and this anatomical variant. Recently, 128-slice computed tomography not only does it directly reveal the positions of mural coronary arteries,

but also evaluates the presence of myocardial band as well as its thickness, and length; It also evaluates changes of arterial lumen size by exhibiting the 'milking effect' allowing accurate and effective selections of stent type which increases the treatment success rate [25].

In all specimens, whether it terminates at or beyond the cardiac crux, the RCA was found to give arterial supply to the inferior wall of the left ventricle. One posterolateral branch was present in 23.3% of specimens; two posterolateral branches were present in 33.3% of specimens; while three posterolateral branches were present in 43.3% of specimens. This means that RCA dominance is present in 100% of specimens in this study. In comparison with other studies, Nerantzis CE et al. 1996 [26] reported RCA dominance in 89% of specimens; these findings explain why proximal lesion of the RCA in right artery dominance can be associated with extensive posterolateral ischaemia and mitral dysfunction and should be of practical importance when considering angioplasty or bypass surgery. Altin C et al. 2015 [27] reported RCA dominance in 81.6%. Regarding the significance of these findings, Veltman CE et al. 2012 [28] found that the presence of left dominant system was identified as an independent predictor of non-fatal myocardial infarction and all-cause mortality. Veltman et al. 2015 [29] found that a left dominant coronary artery system is associated with a significantly increased risk of 30-days mortality and early reinfarction after STEMI; after surviving the first 30-days, post-STEMI, coronary vessel dominance had no influence on long–term outcome. Again Veltman et al. 2014 [30] reported RCA dominance in 86% of cases and found that the presence of left dominant coronary artery system is associated with worse outcome after ST-elevation myocardial infarction compared with right dominance or a balanced coronary artery system.

CONCLUSION

This study directs the attention towards the importance of the right coronary artery in the supply of the myocardium and the patterns obtained here may be clinically relevant during percutaneous coronary interventions or surgical revascularization.

Abbreviations

RCA: right coronary artery
LCx: left circumflex artery
PDA: posterior interventricular or posterior descending artery**.**
STEMI: ST segment elevation myocardial infarction
LCA: left coronary artery
LAD: anterior interventricular or left anterior descending artery
SAN: sino-atrial node.
AVN: atrioventricular node.

Conflicts of Interests: None

REFERENCES

[1]. Davis MJ. Atlas of coronary artery disease. 2nd ed. Philadelphia: Lippincott- Raven 1998:4-12.

[2]. Standring S. Gray's Anatomy:The Anatomical Basis of Clinical Practice. 40th ed. Edinburgh, London, New York, Oxford, Philadelphia, St. Louis, Sydney, Toronto, Elsevier, Chirchill Livingstone,2008;1017-1023.

[3]. Malouf JF, Edwards WD, Tajik AJ, Seward JB. Functional anatomy of the heart. In: Fuster V, Alexander RW and O'Rourke RA, (eds) Hurst: The heart. 12th ed, New York, St Luis, San Francisco, London: Mc Graw Hill, 2008:41-80.

[4]. Nernatzis CE., Marionu SK. Ectopic high origin of both coronary arteries from the left aortic wall: anatomic and postmortum angiographic findings. Clin Anat 2000;13:383–386.

[5]. Piegger, J.; Kovacs, P. and Ambach, E. Extremely high origin of the right coronary artery from the ascending aorta. Clin Anat 2001;14:369-372.

[6]. Angelini P. Normal and anomalous coronary arteries: definitions and classification. Amer Heart J 1989;117:418-434.

[7]. BusquetJ, Fontan F, Anderson RH, Ho SY, Davis MJ. The surgical significance of the atrial branches of the coronary arteries. Int J Cardial 1984;6:223-234.

[8]. Willerson JT, Cohn JN, Manabe H, Yutani C. Atlas of Ischaemic Heart Disease. 1st ed. New York: Churchill living stone. 1997:4-12.

[9]. Koifman B, Egdell R, Somerville J. Prevalence of asymptomatic coronary arterial abnormalities detected by angiography in grown-up patients with congenital heart disease. Cardiol Young 2001;11(6):614–618.

[10]. Kyriakidis MK, Kourouklis CB, Papaicannou Christkos, SG, Spemos GT, Augoustakis DGJT. Sinus node coronary arteries studied with angiography. Am J Cardiol 1983;51:749-750.

[11]. Pejkoviæ B,Krajnc I, Anderhuber F, Kosutiæ, D.Anatomical aspects of the arterial blood supply to the sinoatrial and atrioventricular nodes of the human heart. Journal of International Medical Research 2008;36:691-698.

[12]. Okmen, A.S. and Okmen, E. Sinoatrial node artery arising from posterolateral branch of right coronary artery: definition by screening consecutive 1500 coronary angiographies. Anadolu Kardiyol Derg 2009 Dec;9(6):481-485.
[13]. Ramanathan, Prakash Shetty, Soubhagya R Nayak, Ashwin Krishnamurthy, Ganesh K Chettiar and, Annamalai Chockalingam. Origin of the Sinoatrial and Atrioventricular Nodal Arteries in South Indians: an Angiographic Study. Arq Bras Cardiol 2009;92(5):314-319.
[14]. OzturkE, Saglam M, Bozlar U, Kemal Sivrioglu A, Karaman B, Onat L, Cinar Basekim C. Arterial supply of the sinoatrial node: a CT coronary angiographic study. Int J Cardiovasc Imaging 2011 Apr;27(4):619-627.
[15].Cezlan T, Senturk S, Karcaaltýncaba M, Bilici A. Multidetector CT imaging of arterial supply to sinuatrial and atrioventricular nodes.Surg Radiol Anat 2012 May;34(4):357-365.
[16]. Song YS, Lee W, Park EA, Chung JW, Park JH. Anatomy of the sinoatrial nodal branch in Korean population: imaging with MDCT. Korean J Radiol 2012 Sept;13(5):572-578, 2012.
[17]. Berdajs D, Patonay L, Turina MI. The clinical anatomy of the sinus node artery. Ann Thoracic Surg 2003;76(3):732-735.
[18]. Von Iudinghausen, M. The Clinical Anatomy of Coronary Arteries. Adv Anat Embryol Cell Biol 2003;167:1-111.
[19]. Futami C, Tanuma K, Tanuma Y, Saito T. The arterial blood supply of the conducting system in normal human hearts. Surg Radiol Anat. 2003 Apr;25(1):42-49.
[20]. Arid JM, Armstrong O, Rogez JM, Robert R, Lardoux MC, Leborgne J. Arterial revascularisation of the AVN. Surg Radiol Anat. 2000;22:93-96.
[21]. Sow ML, Ndoye JM, Lo EA. The artery of the AVN. Surg Radiol Anat. 1996;18:183-187.
[22]. Bezarra AJC, Didio LJA, Piva JI. Myocardial bridge over the right coronary artery in man. Surg Radiol Anat 1989;11:271-273.
[23]. Berry JF, Von Mering GO, Schalfuss C, Hill JA, Kerensky RA. Systolic compression of the left anterior descending coronary artery: a case series, review of the literature and therapeutic options including Stenting. Cathet Cardiovasc Interv 2002;56(1):64-65.
[24]. Agirbasli M, Martin GS, Stout JB, Jennings HS, Lea JW. Myocardial bridges as a cause of thrombus formation and myocardial infarction in young Athelete. Clin Cardiol 1997;20:1032– 1036.
[25]. Niu YJ, Zhang XL, A-dan cao, AD, Leng B. Clinical value of the correlations of mural coronary artery compression extent with myocardial bridge length and thickness evaluated by 128-slice CT. Exp Ther Med 2013 Mar;5(3):848–852.
[26]. Nerantzis CE, Papachristos JC, Gribizi JE, Voudris VA, Infantis GP, Koroxenidis G.T. Functional anatomy of the right coronary artery: incidence in human hearts: Clin Anat 1996;9(01):10-13.
[27]. Altin C, Kanyilmaz S, Koc S, GursoyYC, Bal U, AydinolPA, Yildir A, Muderrisoqlu H. Coronary Anatomy, anatomic variation and anomalies: a retrospective study. Singapore Med J 2015 June;56(6):339-345.
[28]. Veltman CE, de Graaf FR, Schuijf JD, van Werkhoven JM, Jukema JW, Kaufman PA, Pazenkottil, AP, Kroft LJ, Boersma E, Bax JJ, Schalij MJ, vander Wall EE.Prognostic value of coronary vessel dominance in relation to significant coronary artery disease determined with non-invasive computed tomography coronary angiography. Eur Heart J 2012 June;33(11):1367-1377.
[29]. Veltman CE, van der Hoeven BL, Hooqslaq GE, Boden H, Kharbanda RK, de Graaf MA, Delgado V, Van Zwet EW, Schaliij MJ, Bax and JJ, Schalte AJ. Influence of coronary vessel dominance on short and long term outcome in patients after ST segment elevation myocardial infarction. Eur Heart J 2015;36:1023-1030.
[30]. Veltman CE, Hooqslaq GE, Kharbanda RK, de Graaf MA, Van Zwet EW,van der Hoeven BL, Delqado V, Bax JJ, ScholteAJ. Relation between coronary arterial dominance and left ventricular ejection fraction after ST-segment elevation myocardial infarction in patients having percutaneous coronary intervention. Am J Cardial 2014 Dec;114(11):1646-1650.

How to cite this article:

El Sayed S. Atta-Alla, Ezzat A. El Sawa, Ahmed E.S. Atta-Alla, Ezdihar A. El Baassiri, Khodor Haidar Hassan. MORPHOMETRIC STUDY OF THE RIGHT CORONARY ARTERY. Int J Anat Res 2015;3(3):1362-1370. **DOI:** 10.16965/ijar.2015.238