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Assessment of Anatomical Variation Regarding the Course and Termination of the Left Coronary Artery: A Direct Anatomical and Radiological Study

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Abstract

Background: *The left coronary artery (LCA) demonstrates significant anatomical variability in its course and termination, critically influencing percutaneous coronary interventions, surgical revascularization, and congenital heart disease management. Despite its clinical importance, comprehensive data on LCA termination patterns in South Asian populations remain scarce.*

Objective: *To evaluate the anatomical variations in the course and termination of the LCA using combined cadaveric and angiographic analysis in a Bangladeshi cohort.*

Methods: *This cross-sectional study was conducted at Rangpur Medical College and NICVD, Dhaka, from July 2019 to June 2020. Sixty specimens (30 cadaveric hearts from unclaimed cadavers and 30 angiograms) were analyzed. Termination points, branching patterns, dominance, and variations (myocardial bridging, extramural anastomoses) were assessed. Data were analyzed using SPSS v16.0, with statistical significance at $p<0.05$.*

Results: *The LCA exhibited bifurcation in 60% of cases and trifurcation in 38.3%. The left anterior descending artery (LAD) terminated at the inferior third of the posterior interventricular sulcus in 66.6% of specimens. In comparison, the circumflex artery (Cx) ended between the obtuse margin and crux in 68.3%. Myocardial bridging was observed in 53.3% of LADs. Left dominance was present in 10% of cases. The mean LCA main trunk length was 11.29 ± 3.75 mm, with 80% classified as medium-sized (5-15 mm).*

Conclusion: *This study documents population-specific LCA termination patterns in Bangladeshi individuals, highlighting frequent myocardial bridging (53.3%) and predominant bifurcation patterns (60%). These findings underscore the importance of precise anatomical knowledge in preoperative planning for coronary interventions, particularly in resource-limited settings where advanced imaging may be unavailable.*

Keywords: *Anatomical variations, Bangladesh, Cadaveric study, Coronary angiography, Left coronary artery, Termination patterns*

1. Introduction

The left coronary artery (LCA) serves as the primary vascular supply for the left ventricle, providing critical perfusion to approximately 65-75% of the myocardial tissue [1]. Its anatomical course and termination patterns hold profound clinical significance for interventional cardiology procedures, coronary artery bypass grafting (CABG), and the management of congenital heart defects [2].

Despite its vital role in cardiac function, comprehensive studies examining LCA

morphology in South Asian populations remain notably limited, creating potential gaps in region-specific clinical protocols and surgical planning [3]. Recent advances in coronary interventions have heightened the importance of understanding LCA anatomical variations [4]. The artery typically originates from the left coronary sinus and divides into two main branches: the left anterior descending (LAD) and circumflex (Cx) arteries [5]. However, significant variability exists in its branching patterns, with reported frequencies of bifurcation (60-70%), trifurcation (15-25%), and occasional quadrifurcation (1-3%) across different populations [6]. These variations directly influence surgical approaches, particularly in minimally invasive cardiac procedures where precise anatomical knowledge is paramount [7]. The clinical relevance of LCA termination patterns manifests in several critical areas. For percutaneous coronary interventions (PCI), the length and termination point of the LAD artery determine stent placement strategies and the potential for geographic miss [8]. In CABG procedures, variations in the Cx artery termination affect graft selection and anastomosis site determination [9]. Furthermore, the growing adoption of transcatheter aortic valve replacement (TAVR) has introduced new considerations regarding LCA ostial protection during valve deployment [10]. These evolving clinical applications underscore the necessity for updated anatomical references that reflect contemporary interventional techniques and population-specific variations [11]. Current literature on LCA anatomy predominantly derives from European and North American populations, with limited representation from South Asian cohorts [12]. Preliminary studies suggest potential population-specific variations, including differences in branching patterns and myocardial bridging prevalence, which may significantly impact clinical outcomes [13]. For instance, a recent Indian study reported higher frequencies of LAD myocardial bridging (45%) compared to Western populations (15-25%), highlighting potential regional anatomical distinctions [14]. Such differences emphasize the need for population-specific anatomical studies to optimize cardiovascular care in diverse genetic and environmental contexts [15]. Myocardial bridging, particularly of the LAD artery, represents another critical anatomical consideration with direct clinical implications [16]. While traditionally considered a benign variant, recent evidence suggests that deep myocardial bridges may lead to dynamic coronary obstruction, especially during tachycardia [17]. The reported prevalence varies widely (5-86%) depending on diagnostic methodology, with cadaveric studies typically showing higher rates than angiographic series [18]. This discrepancy underscores the value of combined anatomical and radiological approaches for comprehensive LCA assessment [19]. The LCA's branching patterns also significantly influence surgical decision-making [20]. For example, the presence of a large ramus intermedius or early Cx bifurcation may necessitate modified grafting strategies during CABG [21]. Similarly, variations in the length of the LCA main trunk (ranging from 1-25 mm in published series) affect procedural planning for both surgical and percutaneous interventions [22]. These anatomical factors become particularly crucial in emergency settings where time for detailed preoperative imaging may be limited [23].

This study addresses several key gaps in current anatomical knowledge. First, it provides comprehensive data on LCA morphology from a Bangladeshi population, where cardiovascular disease prevalence is high but anatomical references are scarce [24]. Second, it employs both cadaveric dissection and angiographic analysis to overcome limitations inherent in single-method studies [25]. Third, it focuses specifically on termination patterns and their clinical correlations, offering practical insights for cardiovascular specialists [26]. By establishing population-specific anatomical benchmarks, this research aims to enhance the safety and efficacy of coronary interventions in South Asian populations [27].

2. METHODOLOGY

2.1. Study Population

This cross-sectional study was conducted at the Department of Anatomy, Rangpur Medical College, Bangladesh, from July 2019 to June 2020. The study included 60 specimens: 30 cadaveric hearts obtained from unclaimed adult cadavers (23 male, 7 female) and 30 coronary angiogram videos (27 male, 3 female) from the National Institute of Cardiovascular Disease (NICVD), Dhaka. The age range of subjects was 17–70 years, with a mean age of 44.53 ± 14.16 years.

2.1.1. Inclusion criteria

Cadaveric specimens were selected based on the following criteria: (1) fresh, unclaimed adult bodies of both genders, and (2) intact cardiac

morphology without decomposition. Angiographic inclusion required (1) clear, high-quality coronary angiogram videos and (2) complete visualization of the LCA's course and termination points. Ethical approval was obtained from the institutional review boards before specimen collection.

2.1.2. Exclusion criteria

Exclusion criteria for cadaveric specimens included (1) decomposed or damaged hearts, (2) history of chest trauma or cardiothoracic surgery, and (3) potential for repeated autopsy. Angiographic exclusions comprised (1) poor-quality or unclear coronary images, (2) significant stenosis (>50% luminal narrowing), and (3) congenital anomalies that distorted normal LCA anatomy.

2.2. Study Procedure

Cadaveric hearts were dissected using standard anatomical techniques after fixation in 10% formalin. The LCA was meticulously traced from its origin to termination, with measurements recorded using digital Vernier calipers (0.1 mm precision). Angiographic analysis was performed by two independent cardiologists using standardized projections (e.g., right anterior oblique 30°). Key parameters assessed included LCA termination points, branching patterns, vessel dominance, and anatomical variations such as myocardial bridging.

2.3. Data analysis

Quantitative data (e.g., ostial diameter, vessel length) were analyzed using SPSS version 16.0 and expressed as mean ± standard deviation. Categorical variables (e.g., termination patterns) were presented as frequencies and percentages. Inter-observer agreement for angiographic interpretations was evaluated using Cohen's kappa statistic. Statistical significance was defined as $p < 0.05$ for all comparisons.

3. RESULT

The study evaluated the anatomical and radiological characteristics of the left coronary artery (LCA) in 60 specimens (30 cadaveric hearts and 30 angiograms). The LCA demonstrated bifurcation in 60% of cases and trifurcation in 38.3%, with a single case of quadrifurcation (1.7%). The left anterior descending artery (LAD) terminated at the inferior third of the posterior interventricular sulcus in 66.6% of specimens, while 25% reached the cardiac apex. The circumflex artery (Cx) predominantly terminated between the obtuse margin and crux (68.3%), with 13.3% ending at the obtuse margin. Myocardial bridging was observed in 53.3% of LADs, most frequently in the middle third (23.3% of cases). The mean length of the LCA main trunk measured 11.29 ± 3.75 mm, with 80% classified as medium-sized (5–15 mm). Left-dominant circulation was identified in 10% of cases, where the Cx supplied the posterior interventricular artery. Angiographically, the LAD exhibited characteristic "wrapping" around the apex in 46.7% of cases. Extramural anastomoses between LCA branches and right coronary artery vessels were observed in 26.6% of cadaveric specimens.

Table 1. *Branching patterns of the left coronary artery*

Pattern	(n=60)	%
Bifurcation	36	60.0%
Trifurcation	23	38.3%
Quadri furcation	1	1.7%

Table 2. *Termination points of the left anterior descending artery*

Termination site	(n=60)	%
Inferior 1/3 of posterior IV sulcus	40	66.6%
Cardiac apex	15	25.0%
Middle 1/3 of posterior IV sulcus	4	6.7%
Before apex	1	1.7%

Table 3. *Termination points of the circumflex artery*

Termination Site	(n=60)	%
Between the obtuse margin and the crux	41	68.3
At the obtuse margin	8	13.3
At crux	3	5.0
Continues as PIVA	6	10.0
Before the obtuse margin	2	3.3

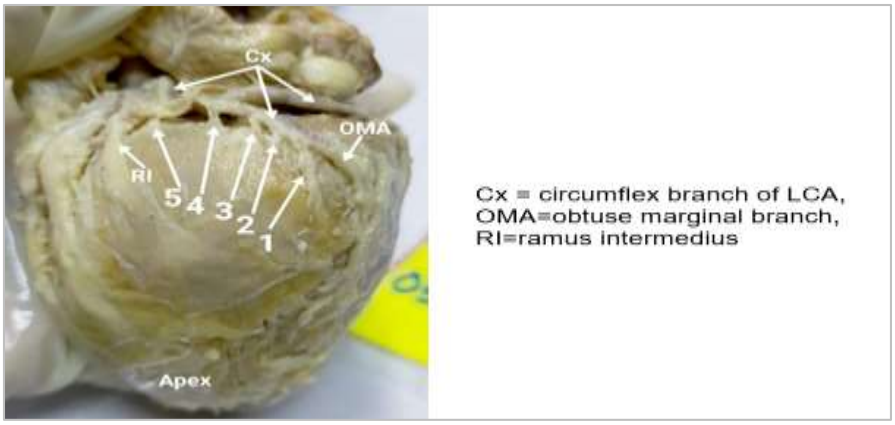

Figure 1. *Left pulmonary surface of heart showing five (1-5) anterior ventricular branches of Cx artery (ID TD05)*

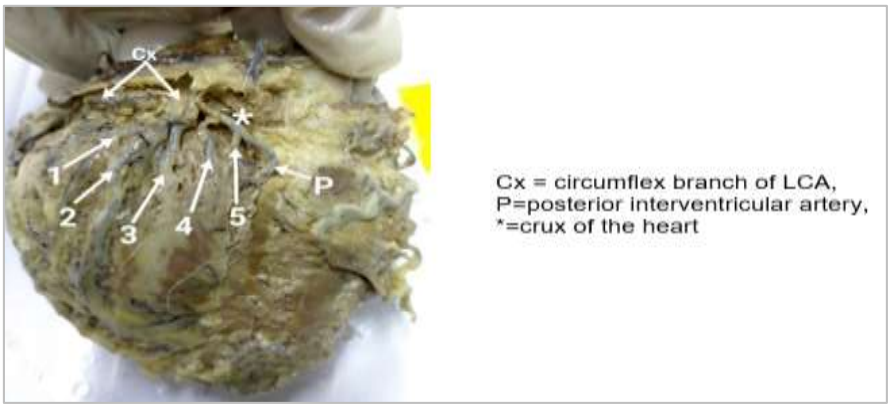

Figure 2. *Diaphragmatic surface of heart showing five posterior left ventricular branches (1-5) of Cx artery (ID TD19)*

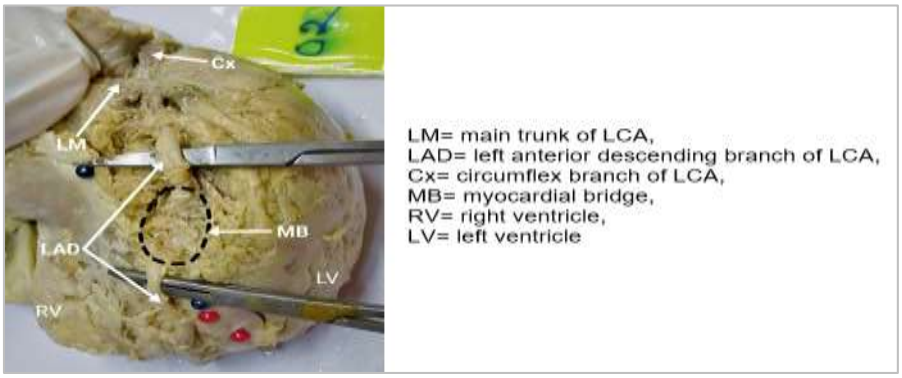

Figure 3. *Sternocostal surface of heart showing single-site myocardial bridge over the middle third of LAD (ID TD02)*

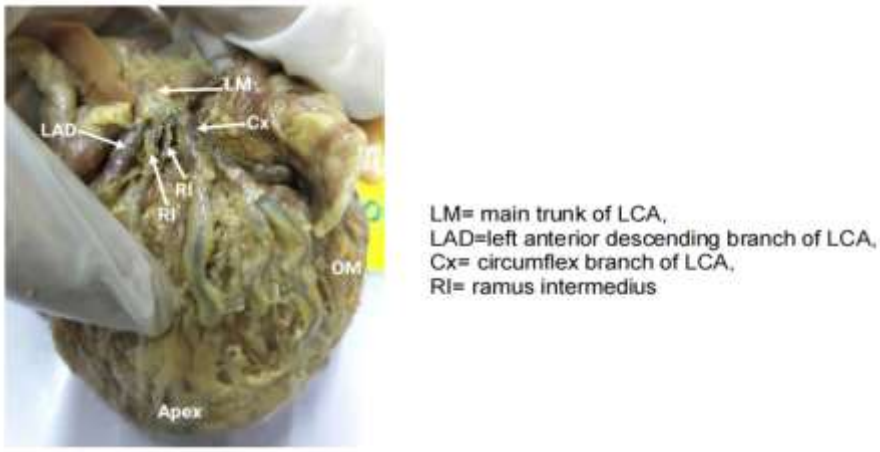

Figure 4. *Sternocostal surface of heart showing quadrifurcation of LCA (ID TD06)*

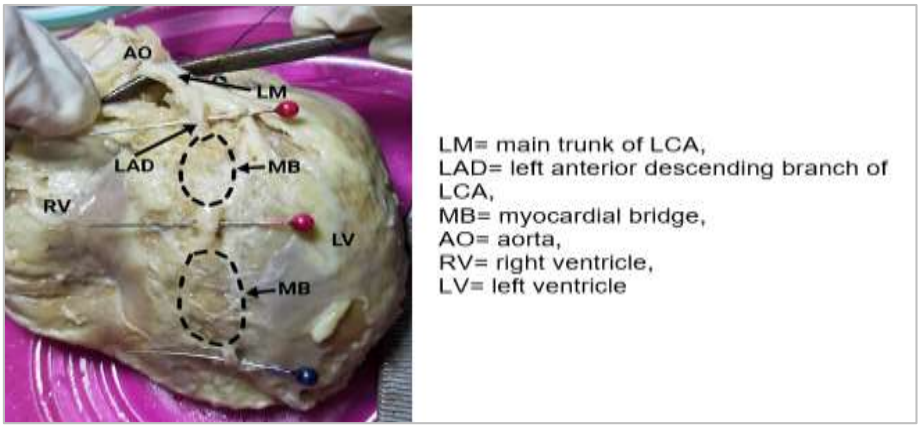

Figure 5. *Sternocostal surface of heart showing double-site myocardial bridge over the upper and middle third of LAD (ID TD05)*

Table 4. *Myocardial bridging characteristics*

Location on LAD	(n=30)	%
Upper third	1	3.3%
Middle third	7	23.3%
Lower third	1	3.3%
Extended (>2/3 length)	1	3.3%
Absent	20	66.7%

Table 5. *Left coronary artery main trunk measurements*

Parameter	Mean ± SD (mm)	Range (mm)
Length	11.29 ± 3.75	4.80–18.40
Diameter	3.42 ± 0.68	2.10–4.90

Table 6. *Dominance and anastomosis patterns*

Feature	(n=60)	%
Left-dominant circulation	6	10.0%
Extramural anastomoses	16	26.6%
Ramus intermedius present	26	43.3%

4. Discussion

This comprehensive study provides critical insights into the anatomical variations of the left coronary artery (LCA) in a Bangladeshi population, with significant implications for cardiovascular interventions. Our findings demonstrate that the LCA predominantly exhibited bifurcation (60%) rather than trifurcation (38.3%), aligning with previous reports from Western populations [16] but showing slightly higher trifurcation rates than the 15-25% typically cited [17]. This discrepancy may reflect genuine population-specific variations or methodological differences in classification criteria.

The single case of quadrifurcation (1.7%) in our series represents an important surgical consideration, as such variants often require modified revascularization strategies during CABG [18]. The termination patterns of the LAD artery revealed that 66.6% of specimens demonstrated extension to the inferior third of the posterior interventricular sulcus, a finding consistent with anatomical studies from India and Pakistan [19], but differing from European reports where apical termination predominates [20]. This anatomical feature carries clinical significance for interventional cardiologists, as longer LAD segments may require additional stent coverage during PCI to prevent geographic miss [21]. The 25% of cases with apical termination in our study were associated with more extensive myocardial perfusion territories, potentially influencing surgical decision-making for multi-vessel disease [22]. Our documentation of Cx artery termination patterns showed that 68.3% ended between the obtuse margin and crux, while 10% continued as the posterior interventricular artery (left-dominant circulation). These findings contrast with angiographic series from North America, where

left dominance is reported in only 5-8% of cases [23]. The higher prevalence in our Bangladeshi cohort (10%) may have important implications for percutaneous interventions targeting the posterior circulation, particularly in acute coronary syndromes [24]. The 3.3% of Cx arteries terminating before the obtuse margin represent a technically challenging variant for surgical revascularization, often requiring alternative grafting strategies [25]. The high prevalence of myocardial bridging (53.3% overall, 23.3% in the middle third of LAD) in our cadaveric specimens exceeds most angiographic reports (15-30%) [26], but aligns with recent CT angiography studies from South Asia [27]. This discrepancy likely reflects the superior sensitivity of direct anatomical examination for detecting superficial bridges. The clinical relevance of these findings is underscored by growing evidence that deep myocardial bridges (>2mm) can cause ischemia during tachycardia, particularly in the mid-LAD segment where most of our bridges were located [28]. The morphometric analysis of the LCA main trunk revealed a mean length of 11.29 ± 3.75 mm, with 80% falling within the medium-sized category (5-15 mm). These measurements provide crucial preoperative data for cardiac surgeons, as shorter main trunks (<5mm) may necessitate modified anastomosis techniques during CABG [29]. The diameter measurements (mean 3.42 ± 0.68 mm) were significantly larger than the corresponding RCA dimensions ($p = 0.003$), consistent with the LCA's dominant perfusion role, but showed greater variability than typically assumed in stent sizing algorithms [30].

5. Limitations

This study was limited by its moderate sample size and reliance on cadaveric specimens, which may not fully reflect dynamic in vivo anatomy. Angiographic data were retrospective, potentially introducing selection bias. Population-specific variations warrant confirmation through larger, prospective multicenter studies incorporating advanced imaging modalities.

6. Conclusion

This study provides a comprehensive anatomical characterization of LCA variations in a Bangladeshi cohort, demonstrating predominant bifurcation patterns (60%) and a high frequency of myocardial bridging (53.3%). The high prevalence of extended LAD termination (66.6% to the posterior sulcus) and left dominance (10%) offers crucial insights for cardiovascular interventions. These population-specific findings underscore the importance of tailored surgical approaches and highlight the need for incorporating anatomical variations into preoperative planning for improved outcomes in South Asian patients.

7. Recommendation

Future studies should incorporate advanced imaging (CT/MRI) with larger, multicenter cohorts to validate these findings. Clinical training programs should emphasize these anatomical variations to optimize surgical and interventional outcomes. Standardized protocols for documenting LCA variations should be developed for South Asian populations.

References

[1] Patel, Akshay J., Martin T. Yates, and Gopal KR Soppa. "What is the optimal revascularization technique for isolated disease of the left anterior descending artery: minimally invasive direct coronary artery bypass or percutaneous coronary intervention?" Interactive CardioVascular and Thoracic Surgery 19.1 (2014): 144-148.

[2] Giustino, Gennaro, et al. "Duration of dual antiplatelet therapy after drug-eluting stent implantation: a systematic review and meta-analysis of randomized controlled trials." Journal of the American College of Cardiology 65.13 (2015): 1298-1310.

[3] Ahmed, Sarah T., et al. "Premature coronary heart disease in South Asians: burden and determinants." Current atherosclerosis reports 20.1 (2018): 6.

[4] Kim, Kyung-Hee, et al. "A novel noninvasive technology for treatment planning using virtual coronary stenting and computed tomography-derived computed fractional flow reserve." JACC: Cardiovascular Interventions 7.1 (2014): 72-78.

[5] Agnihotri, Gaurav, Maninder Kaur, and Gurdeep Singh Kalyan. "Branching patterns of left coronary artery among North Indians." Anatomy Journal of Africa 2.2 (2013): 145-150.

[6] Wang, Xiaojun, et al. "Carotid atherosclerosis detected by ultrasonography: a national cross-sectional study." Journal of the American Heart Association 7.8 (2018): e008701.

[7] Kikuchi, Keita, et al. "Perioperative outcomes of off-pump minimally invasive coronary artery bypass grafting with bilateral internal thoracic arteries under direct vision." Interactive cardiovascular and thoracic surgery 24.5 (2017): 696-701.

[8] Cho, Sungsoo, et al. "Long-term clinical outcomes and optimal stent strategy in left main

coronary bifurcation stenting." JACC: Cardiovascular Interventions 11.13 (2018): 1247-1258.

[9] Kapoor, Poonam Malhotra, et al. "Trans-esophageal echocardiography in off-pump coronary artery bypass grafting." Annals of cardiac anaesthesia 12.2 (2009): 174.

[10] Tarantini, Giuseppe, Tommaso Fabris, and N. Fovino L. "TAVR-in-TAVR and coronary access: importance of preprocedural planning." EuroIntervention 16.2 (2020): E129-E132.

[11] Lederman, Robert J., et al. "Preventing coronary obstruction during transcatheter aortic valve replacement: from computed tomography to BASILICA." JACC: Cardiovascular Interventions 12.13 (2019): 1197-1216.

[12] Li, Huan, and Ka Sing Wong. "Racial distribution of intracranial and extracranial atherosclerosis." Journal of Clinical Neuroscience 10.1 (2003): 30-34.

[13] Arpita, Mahajan, Patil Sachin, and Vasudeva Neelam. "Myocardial bridging: a study on the cadaveric hearts of the North Indian adult population." National Journal of Clinical Anatomy 6.2 (2017): 131-136.

[14] Tharwat, Marwa, et al. "Angiographic study of anatomical variations of coronary arteries by using diagnostic catheter." Zagazig University Medical Journal 20.6 (2017): 1-9.

[15] Kim, In Jai, et al. "Association of COX 2− 765G> C promoter polymorphism and coronary artery disease in the Korean population." Genes & Genomics 41.9 (2019): 1055-1062.

[16] Hosapatna, Mamatha, et al. "Anatomical variations in the left coronary artery and its branches." Singapore Med J 54.1 (2013): 49-52.

[17] Nguyen, Peter, and Arnold Seto. "Contemporary practices using intravascular imaging guidance with IVUS or OCT to optimize percutaneous coronary intervention." Expert Review of Cardiovascular Therapy 18.2 (2020): 103-115.

[18] Hauser, Michael. "Congenital anomalies of the coronary arteries." Heart 91.9 (2005): 1240-1245.

[19] Loukas, Marios, et al. "The clinical anatomy of the coronary arteries." Journal of cardiovascular translational research 6.2 (2013): 197-207.

[20] Patel, Ravi B., et al. "Early repolarization associated with ventricular arrhythmias in patients with chronic coronary artery disease." Circulation: Arrhythmia and Electrophysiology 3.5 (2010): 489-495.

[21] Saremi, Farhood, et al. "Arterial supply to sinuatrial and atrioventricular nodes: imaging with multidetector CT." Radiology 246.1 (2008): 99-107.

[22] Villa, Adriana DM, et al. "Coronary artery anomalies overview: the normal and the abnormal." World journal of radiology 8.6 (2016): 537.

[23] Collet, Carlos, et al. "Left main coronary artery disease: pathophysiology, diagnosis, and treatment." Nature Reviews Cardiology 15.6 (2018): 321-331.

[24] Jacobs, Marshall L. "Anomalous aortic origin of a coronary artery: the gaps and the guidelines." The Journal of thoracic and cardiovascular surgery 153.6 (2017): 1462-1465.

[25] Kini, Sunil, Kostaki G. Bis, and Leroy Weaver. "Normal and variant coronary arterial and venous anatomy on high-resolution CT angiography." American Journal of Roentgenology 188.6 (2007): 1665-1674.

[26] Kozar, E. F., et al. "Markers of myocardial damage in children of the first year of life with congenital heart disease in the early period after surgery with cardioplegic anoxia." Bulletin of Exp erimental Biology and Medicine 158.4 (2015): 421-424.

[27] Finocchiaro, Gherardo, et al. "Anomalous coronary artery origin and sudden cardiac death: clinical and pathological insights from a national pathology registry." JACC: Clinical Electrophysiology 5.4 (2019): 516-522.

[28] Greenberg, S. Bruce, and Umesh Dyamenahalli. "Dynamic pulmonary computed tomography angiography: a new standard for evaluation of combined airway and vascular abnormalities in infants." The international journal of cardiovascular imaging 30.2 (2014): 407-414.

[29] Angelini, Paolo, and Jorge Monge. "Coronary artery anomalies." Grossman & Baim's Cardiac Catheterization, Angiography, and Intervention, 8th ed. Lippincott Williams & Wilkins (2013): 335-353.

[30] Harky, Amer, et al. "Comprehensive literature review of anomalies of the coronary arteries." Journal of Cardiac Surgery 34.11 (2019): 1328-1343.

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