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Original Research Article

CLINICALLY RELEVANT MORPHOMETRIC STUDY OF LEFT CORONARY ARTERY IN ADULT HUMAN CADAVERS

Manisha Randhir Dhobale*[1], Nitin Radhakishan Mudiraj [2], Medha Girish Puranik[3].

[*1] Associate Professor, Dept. of Anatomy, Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli. State- Maharashtra, India.

[2] Professor and Head, Dept. of Anatomy, Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli. State- Maharashtra, India.

[3] Professor, Dept. of Anatomy, Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Pune. State- Maharashtra, India.

ABSTRACT

Background: The anatomical variations of left coronary artery [LCA] determine the course in the pathogenesis of atherosclerosis, mechanical stress and hemodynamic change.

Aim: To study the gross anatomy of left coronary artery [LCA] in terms of its origin, termination, branching pattern, dominance pattern, external diameter at origin, length of main trunk of left coronary artery, variations and/ anomalies if present.

Materials and Methods: After an ethical approval, 150 adult human cadaveric hearts were collected from Department of Anatomy, B.V.D.U. Medical College and Hospital, Sangli and Pune. The careful dissection was carried out to note details about left coronary artery and data was analyzed using SPSS software.

Results: The origin of left coronary artery was observed in the left posterior aortic sinus 100%. The incidence of bifurcation, trifurcation and quadrifurcation was 69.33, 28% and 2.67% respectively. SA nodal artery was directly arising from main trunk of left coronary artery in 2 hearts (1.33%). Circumflex branch of left coronary artery gave SA nodal artery, AV nodal artery and posterior interventricular artery in 18.66%, 16% and 16% hearts respectively. In one case (0.66%), we found a hyperdominant left anterior descending artery which continued as posterior interventricular artery [PDA] occupying entire posterior interventricular sulcus and terminated at crux of the heart by giving AV nodal artery. Hence left dominance was observed in total 16.66% cases. The mean external diameter of left coronary artery at its origin was 5.02 ±1.0328. Length of main trunk of left coronary artery was ranging from 4 mm to 22 mm with mean length of 11.66±3.529 mm.

Conclusion: Short or long main trunk of left coronary artery, small diameter of main trunk, additional terminal branches of left coronary artery, left coronary artery dominance, Mouchet's posterior recurrent interventricular artery, hyperdominanant left anterior descending artery are the significant anatomical factors which decide the extent of coronary insufficiency, its functional impact and may create challenges during the interventional coronary care.

KEY WORDS: left coronary artery, LAD, hyperdominant left anterior descending artery, median artery, Mouchet's posterior recurrent interventricular artery, dominance, trifurcation, quadrifurcation.

Address for Correspondence: Dr. Manisha Randhir Dhobale, Associate Professor, Dept. of Anatomy, Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli. State- Maharashtra, India. **E-Mail:** drmanisha.dhobale@gmail.com

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INTRODUCTION

Human heart is supplied by right and left coronary arteries. The left coronary artery [LCA] arises from the left posterior aortic sinus of the ascending aorta. It runs between the pulmonary trunk in front and the left atrial appendage behind with characteristic upward loop. It lies free in the subepicardial tissue of the atrioventricular sulcus. Usually the left coronary artery terminates by dividing into the left anterior descending artery [LAD] and circumflex artery [1]. At various sites, the branches of left coronary make anastomosis with that of right coronary or large third coronary, if later is present [1, 2]. Many variations of left coronary artery are mentioned in the literature. These anatomical variations of coronary arteries determine the course in the pathogenesis of atherosclerosis, mechanical stress and haemodynamic changes [3]. The amount of myocardium supplied by a coronary vessel is related to the size of that proximal vessel [4]. Left coronary artery is wider than right coronary artery and it supplies larger volume of myocardium [5]. Dharmendra P et al recommended that outer diameter of left main coronary artery is important in estimating the extent and severity of dilatation in cases of coronary aneurysm, calcification and stenosis [6]. The length of the main trunk of left coronary artery is important for the cannulae used in myocardial perfusion during aortic valve surgery [7].

The main trunk of left coronary artery [MLCA] is described as 'long' when it is above 15 mm and 'short' when it measures equal to or less than 5 mm [8]. N. Gazetopoulos (1976) suggested that the length of main left coronary artery is a congenital, anatomical and possibly hereditary factor influencing the rate of development of atherosclerosis in the branches of the main left coronary artery [9]. Charles Welch reported that the LAD artery is most frequently involved and affected in 60% of single vessel disease [10]. Considering clinical significance of the left coronary artery, present study had been conducted to record gross anatomy of left coronary artery in terms of its origin, termination, branching pattern, dominance pattern, external diameter at its origin, length of main trunk of left coronary artery and variations and/ anomalies if present.

MATERIALS AND METHODS

After an ethical approval, 150 formalin fixed adult human cadaveric hearts were collected from Department of Anatomy, B. V. D. U. Medical College and Hospital, Sangli and Pune. The hearts having gross congenital anomalies were excluded.

Ascending aorta is transversely sectioned approximately 1cm above the aortic leaflets. Then the aorta is longitudinally opened at the level of posterior aortic sinus (non-coronary sinus) to visualize the positions of coronary ostia. Depending on whether the ostia were situated below, at or above the sinotubular junction, origins were classified as having sinus, sinotubular and tubular.

Epicardium and fat was removed in piecemeal. The main left coronary artery was dissected from its origin to its course between left auricle and pulmonary trunk. It usually bifurcates but additional branches, if any were also observed.

The anterior interventricular artery dissected by tracing along the anterior interventricular sulcus, then around the incisura apicis cordis to the diaphragmatic surface. The circumflex branch was traced along the coronary sulcus around up to its termination.

Following observations were noted in relation with left coronary artery:

1. Site of ostium (origin)

2. Course, branching pattern and termination of left coronary artery

3. Pattern of dominance depending upon origin of posterior interventricular artery

4. External diameter of trunks of left coronary artery at their origin was measured with vernier caliper.

5. Length of main trunk of left coronary artery from its origin up to its division was measured with divider and calibrated scale. This parameter was measured taking care not to stretch the wall.

The most representative specimens were photographed with digital Kodak camera.

RESULTS

The ostium of the left coronary artery was observed in the left posterior aortic sinus (LPAS) in all hearts (100%). The location of ostia has been shown in Table 1.

Table 1: Showing locations of ostium of left coronary artery.

Location of ostia	No. of Cases	Percentage of Cases
Sinus (S)	10	6.67
Sinotubular (ST)	113	75.33
Tubular (T)	27	18

In 104 hearts (69.33%) left coronary artery bifurcated into anterior interventricular artery i.e. left anterior descending artery (LADA) and circumflex artery [Fig.-1].

In 42 hearts (28%) main trunk of left coronary artery was trifurcated into left anterior descending, circumflex branch and median artery (ramus intermedius) (RI) [Fig.- 2]. In 4 cases (2.67%) quadrifurcation was observed. In these cases, left coronary artery divided into anterior interventricular, circumflex branch and two median arteries [Fig.- 3].

The extent of left anterior descending branch of left coronary artery is shown in Table- 2.

Table 2: Showing the extent of left anterior descending artery.

Extent	No. of hearts	Percentage
Up to anterior aspect of apex	42	28
Running in posterior interventricular groove for a distance less than half of its length	105	70
Running in posterior interventricular groove for a distance more than half of its length	2	1.33
Hyperdominant left anterior descending artery which continued as posterior interventricular artery [PDA] occupying entire posterior interventricular sulcus and terminated at crux of the heart by giving AV nodal artery [Fig. 4]	1	0.66

The left anterior interventricular artery along its course gave septal and ventricular branches. Septal branches passed perpendicular to the artery and supplied interventricular septum. It gave 3-4 diagonal branches from its left to supply left ventricle. In one case, we found a hyperdominant left anterior descending artery which continued as posterior interventricular artery [PDA] occupying entire posterior interventricular sulcus and terminated at crux of the heart by giving AV nodal artery [Fig. 4].

The extent of circumflex branch of left coronary artery is shown in Table 3.

Table 3: Showing the extent of circumflex artery (Cx).

Extent	No. of hearts	Percentage
Before obtuse margin	0	0
At obtuse margin	1	0.66
Between obtuse margin and crux	125	83.33
At crux [Fig. 5]	20	13.33
Beyond crux [Fig. 6]	4	2.66

Origin of SA nodal artery is shown in Table 4 and Figures 1, 7, 8.

Table 4: Showing origin of SA nodal artery from left coronary artery.

Origin from	No. of hearts	Percentage
Main trunk of left coronary artery [Fig.7,8]	2	1.33
Circumflex branch of left coronary artery [Fig.1]	28	18.66
Total	30	20

Origin of AV nodal artery is shown in Table 5 and Figures 4, 5. In 2 cases (1.33%) of present study, both SA node and AV node of the same heart received blood supply from circumflex branch of left coronary artery.

Table 5: Showing origin of AV nodal artery from left coronary artery.

Origin from	No. of hearts	Percentage
Circumflex branch of left coronary artery [Fig.5]	24	16
From Left Anterior Descending Artery [Fig. 4]	1	0.66
Total	25	16.66

Occurrence of left conus branch of left anterior descending artery was not a constant feature. It was found in 2 cases (1.33%) forming a circle of Vieussens with right conus branch of right coronary artery [Fig. 9]

Posterior interventricular artery (PIVA) was a branch of circumflex artery in 24 hearts (16%) and it was given by those circumflex arteries which were extended up to the crux or beyond crux [Fig. 5, 6]. Posterior interventricular artery was a continuation of hyperdominant left anterior descending artery in one heart (0.66%) [Fig. 4]. Hence left dominance was observed in total 16.66% cases.

The mean external diameter of left coronary artery at its origin was 5.02 ± 1.0328 mm.

In present study, length of main trunk of left coronary artery was ranging from 4 mm to 22 mm with mean length of 11.66 ± 3.529 mm. Length of main trunk was found 'short' in 4 hearts

and 'long' in 19 hearts. The mean length of main trunk of left coronary artery was 11. 4903 ± 3.68 mm in case of bifurcation, 12.1667 mm ± 3.1923 mm in trifurcation and 11.75±2.8722 mm in quadrifurcation. There was no correlation of length of trunk of left coronary artery and number of divisions. (P > 0.05).

Fig. 1: Bifurcation of left coronary artery into left anterior descending [1] and circumflex artery [2]. SA nodal artery [3] is arising from circumflex artery.

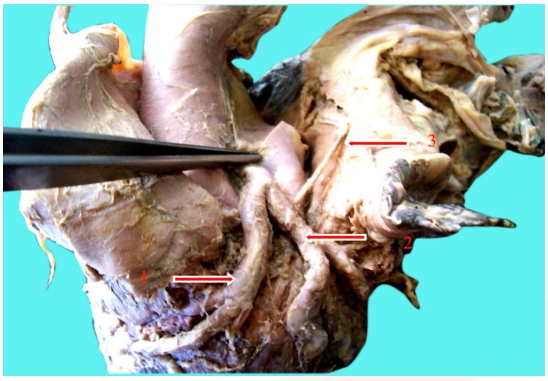


Fig. 2: Trifurcation of left coronary artery into left anterior descending [1], median artery [2] and circumflex artery [3].

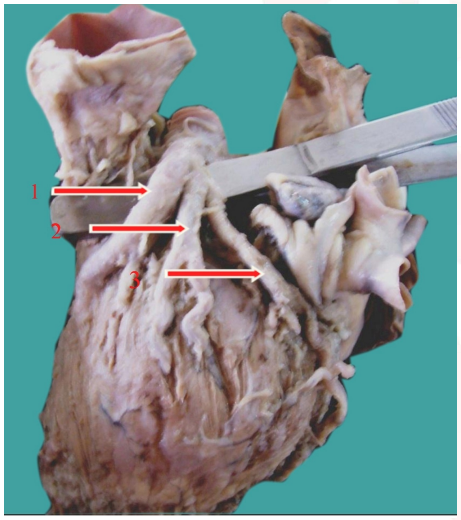


Fig. 3: Quadrifurcation of left coronary artery into left anterior descending [1], two median areries [2a &2b] and circumflex artery [3].

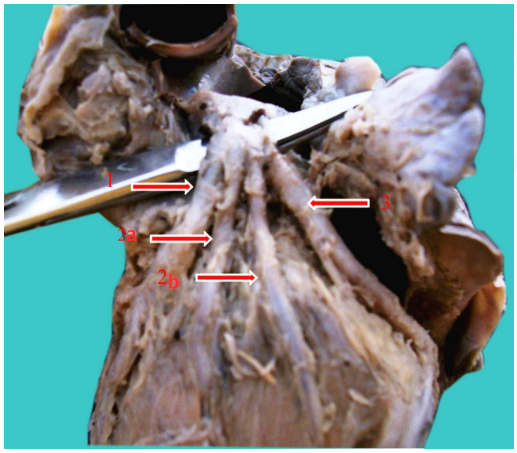


Fig. 4: Hyperdominant left anterior descending artery which continued as posterior interventricular artery [Arrow] and terminated at crux of the heart by giving AV nodal artery.

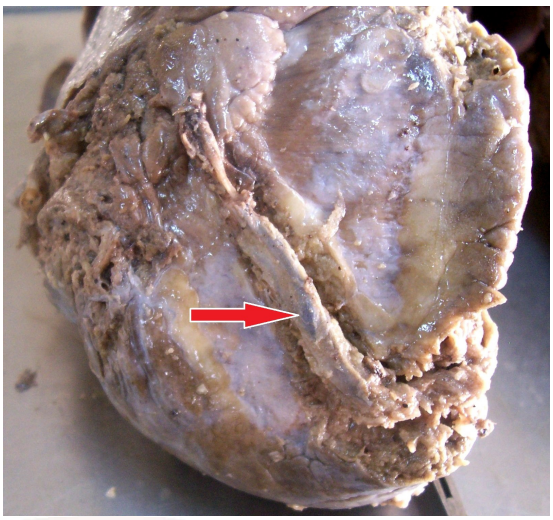


Fig. 5: AV nodal artery [1] and Posterior interventricular artery [2] arising at crux from circumflex branch [3] of left coronary artery hence presenting left dominance.

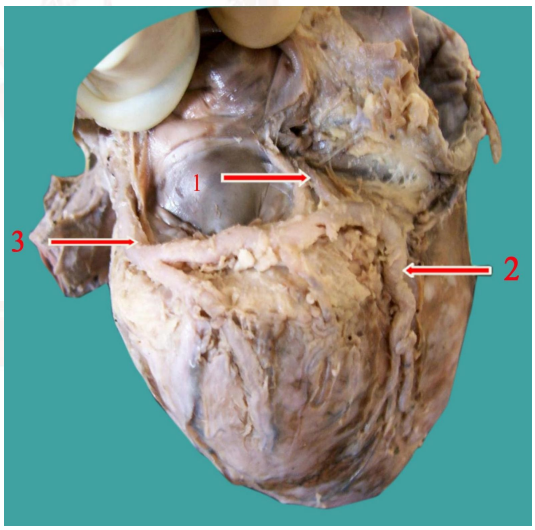


Fig. 6: Circumflex branch [1] of left coronary artery after giving posterior interventricular artery [2] is extending beyond crux and supplying entire diaphragmatic surface.

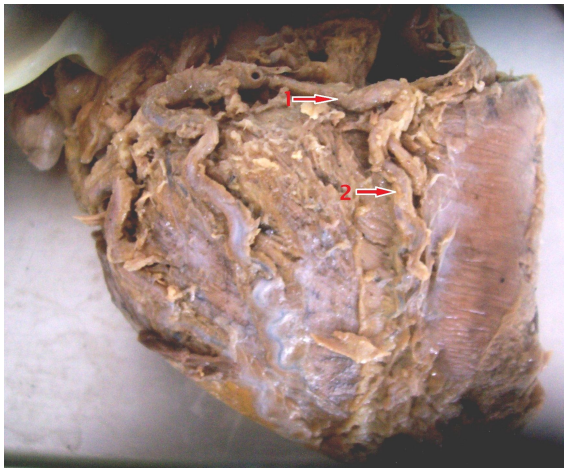


Fig. 7: Main trunk of left coronary artery [1] showing origin of SA nodal artery [2] and trifurcating [*].

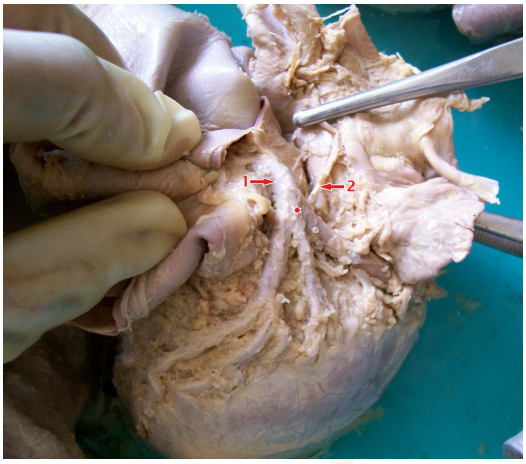


Fig. 8: Main trunk of left coronary artery [1] showing origin of SA nodal artery [2] and quadrifurcation [*].

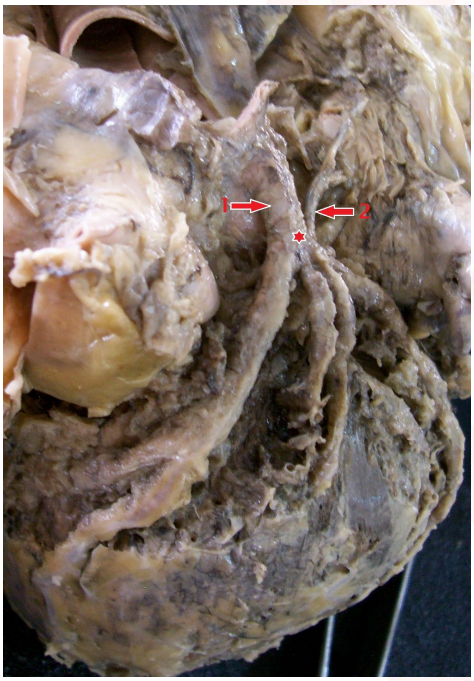
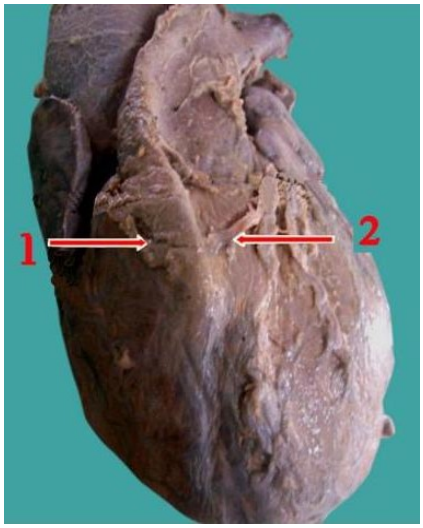


Fig. 9: Right conus branch of right coronary artery [1] and left conus branch [2] of left anterior descending artery forming Circle of Vieussens.



DISCUSSION

The LCA is the main source of blood supply to the heart [11, 5]. Its ostium is found normally in left posterior aortic sinus most frequently at the sinotubular junction. In present study, we found the same as most common site. This location allows maximum filling of the coronary arteries in diastole [1].

High and low coronary orifices are associated with an additional difficulty in cannulating the coronary vessels during open aortic surgery or in performing coronary arteriography [12]. Also high left coronary orifice is usually associated with a long left coronary artery which is at a greater risk of injury during surgery, either due to a low clamping of the aorta or due to the incision of the aortic wall during valvular replacement [8].

Left coronary artery usually bifurcates into left anterior descending artery and circumflex artery. But it may show trifurcation, tetrafurcation and pentafurcation [13]. The additional terminal branch(es) is called as median artery. It is also called as ramus intermedius (RI) [8, 14,15]. Ajayi NO et al proposed that in cases of more than one additional terminal branches, they may be labeled by adding the suffix I, II and III for the third, fourth and fifth branches of the LCA respectively, starting from the vessel closest to the anterior interventricular artery [16].

The median artery of large caliber may give branches to the sterno-costal surface of the left ventricle, one or more anterior septal arteries and branches to the anterior papillary muscle of the left ventricle [8]. This branch, including its anastomoses, presents important pattern of collateral blood flow. Therefore existence of this artery may decrease the effect of occlusion of left anterior descending artery. Pepler and Mayer reported that lower incidence of angina pectoris and myocardial infarctions in Bantu population proves that having a median artery is beneficial where highest incidence of trifurcation (74%) was noted [17]. On the contrary, occlusion of large median artery may result in larger infract. Therefore it should be carefully looked for during coronary angiography. These additional terminal branches of left coronary artery may be a source of complication or

misdiagnosis. Trifurcation stenting carries a high rate of adverse events like stent thrombosis and since this vessel is not within any anatomical groove, stent deployment would have a poor support and prone for mobilisation and migration [18].

The Left anterior descending artery [LAD] descends in the corresponding groove along the sternocostal surface to the apex and after winding around incisura apices cordis it ends on the inferior surface by anastomoting with the posterior interventricular branch usually at the junction of anterior 1/3rd and posterior 2/3 rd of the posterior interventricular groove [1].

The portion of left anteior descending artery that lodging in posterior interventricular groove is called as Muchet's posteior recurrent interventricular artery [8]. A large left anterior descending artery [LAD] continuing as posterior interventricular artery [posterior descending artery-PDA] is referred as 'hyperdominant' or 'superdominant' left anterior descending artery where posterior descending artery arises from LAD instead of left circumflex or right coronary artery [19, 20].

We found a case of hyperdominant left anterior descending artery which continued as posterior interventricular artery [PDA] occupying entire posterior interventricular sulcus and terminated at crux of the heart by giving AV nodal artery. Similar finding was reported by Musselman and Tate [21]. R. Akdimir et al reported a case of simultaneous anterior and inferior myocardial infarction due to occlusion of such hyperdominant LAD [22]. In individuals with left coronary artery dominance patterns, a great amount of myocardium which includes the entire left ventricle, left auricle, interventricular septum and part of right ventricle depends entirely on left coronary artery for its nutrition. Obstruction of this artery may produce a massive infarct with output failure of the heart. Kuno T, Numasawa Y, Miyata H, et al reported that the numbers of patients presenting with symptoms of heart failure, cardiogenic shock, or cardiopulmonary arrest were significantly higher in the patients having left coronary artery dominance than in the patient with right coronary dominance [23]. Hence according to Goldberg et al, left dominance is a significant and independent predictor of increased long-term mortality in patients with acute coronary syndrome [24].

The appropriate treatment options in managing coronary artery disease mainly depend upon the size of the coronary artery. Smaller arteries affects outcome in procedures such as balloon angioplasty and stenting, and may cause anastomotic difficulties during bypass grafting [25]. In addition, small target vessel size is associated with an increased risk of re-stenosis and repeat revascularization [26, 27, 28].

We found an arterial circle of Vieussens in 2 hearts which is an important source collateral blood flow between right and left coronary arteries especially in patients of stenosis or total occlusion of left coronary artery.

Existence of short trunk is the risk factor for development of atherosclerosis and a cause of blockage in the left branch of the bundle of His [29]. The short common trunk is clinically important especially when a perioperative coronary perfusion or angiography is performed, because an image of the area of distribution of LCA may be seen on introducing a catheter into only one of the terminal branches and the other does not show opacification leading to misdiagnosis [30]. Green et al raised the possibility of preoperative occlusion of main branch of LCA by a coronary canula in case with an early bifurcation [31].

Allen D. Johnson (1978) concluded that, patients with congenital bicuspid aortic valve had a higher incidence of immediate bifurcation of main trunk of left coronary artery giving rise to short trunk and also higher incidence of left coronary artery dominance [32].

Considering the clinical aspect pertaining to the left coronary artery, sound anatomical knowledge is necessary for accurate interpretation of diagnostic tests, clinical assessment of coronary insufficiency and management of coronary artery disease.

CONCLUSION

Short or long main trunk of left coronary artery, small diameter of main trunk, additional terminal branches of left coronary artery, left coronary artery dominance, Mouchet's posterior

recurrent interventricular artery, hyperdominanant left anterior descending artery are the significant anatomical factors which decide the extent of coronary insufficiency, its functional impact and may create challenges during the interventional coronary care.

Conflicts of Interests: None

REFERENCES

[1]. Williams, Peter, Bannister, Lawrence H.; Berry, Martin M.; Collins; Patricia, Mary Dyson; Dussek, Julien E.; Ferguson, Mark W. J.; Gray's Anatomy, The Anatomical Basis for Medicine and Surgery, 38th edition, ch.-10 ' Cardiovascular system, The arterial system', edited by Giorgio Glabella Pg-1505-1510, Churchill Livingstonee, Edinburg, London, 1995.

[2]. Dhobale MR, Puranik MG, Mudiraj NR, Joshi UU. Study of Third Coronary Artery in Adult Human Cadaveric Hearts. Journal of Clinical and Diagnostic Research/ : JCDR. 2015;9(10):AC01-AC04. doi:10.7860/JCDR/2015/14735.6676.

[3]. Gazetopoulos N, Ioannidis Pj, Karydis C, Lolas C, Kiriakou C And Tountas C (1976). Short left coronary artery trunk as a risk factor in the development of coronary atherosclerosis. Pathological study. Brit Heart J; 38:1160-1165.

[4]. Koiwa Y, Bahn RC , Ritman EL. Regional myocardial volume perfused by the coronary artery branch estimation in vivo. Circulation. 1986; 74: 157-63.

[5]. Kalbfleisch H, Hort W. Quantitative study on the size of coronary artery supplying areas postmortem. Am Heart. 1977; 94: 183-188.

[6]. Dharmendra P, Anitha T, Madan S, Londhe P. Clinically significant anatomical variations of the left coronary artery in human cadaveric hearts. Int J Cur Res Rev 2013; 5: 39-44.

[7]. Fox C, Davies MJ, Webb-Peploe MM. Length of left main coronary artery. Br Heart J. 1973; 35(8):796-8.

[8]. Vilallonga JR. Anatomical variations of the coronary arteries: I The most frequent variations. Eur J Anat 2003; 7:29-41.

[9]. Gazetopoulos N, Ioannidis P. J, Karydis O, Lolas C, Kiriakou K, and Tountas C. Short left coronary artery trunk as risk factor in the development of coronary atherosclerosis- Pathological study. Br Heart J.1976; 38:1160-65.

[10] Welch CC, Proudfit WL, Sheldon WC. Coronary arteriographic findings in 1000 women under age 50. Am J Cardiol. 1975; 35: 211–15.

[11]. Reig J, Petit M. Main trunk of the left coronary artery: Anatomic study of the parameters of clinical interest. Clinical Anatomy. 2004; 17: 6–13.

[12]. Greenberg MA, Fish BG, Spindola-Franco H. Congenital anomalies of the coronary arteries: Classification and significance. Radiol Clin North Am 1989; 27:1127–46.

[13]. Kalpana R. A study on principal branches of coronary artery in humans.J Anat Soc India.2003; 52(2): 137-140.

[14]. Kilic C, Kirici Y. Third branch derived from left coronary artery: the medial artery. Gulhane tip Dergisi 2007; 49: 232–235.

[15]. Fiss DM. Normal coronary anatomy and anatomic variation. Applied Radiol. 2007, 36: 14-26.

[16]. Ajayi NO, Lazarus L, Vanker EA, Satyapal KS. The prevalence and clinical importance of an "additional" terminal branch of the left coronary artery. Folia Morphol 2013; 72(2): 128-131.

[17]. Pepler WJ, Meyer BJ. Interarterial coronary anastomoses and coronary arterial pattern. Circulation 1960; 22: 14-23.

[18]. Shammas NW., Dippel E.J., Avila A., Gehbaur L., Farland L., Brosius S., Jerin M., Winter M., Stoakes P., Byrd J., Majetic L., Shammas G., Sharis P., Robken J. Long-Term Outcomes in Treating Left Main Trifurcation Coronary Artery Disease with the Paclitaxel-Eluting Stent. J Invasive Cardiol 2007; 19(2): 77-82.

[19]. Mannuva BB, Durgaprasad R, Vanajakshamma V. Hyperdominant left anterior descending artery continuing as posterior descending artery: a rare coronary artery anomaly. Cath Lab Digest. 2013; 21(1).

[20]. Deora S, Shah S, Patel T. Superdominant left anterior descending artery continuing as posterior "ascending" and posterior left ventricular branch: a rare coronary anomaly. Internat J Cardiol.2013; 168(4): e121-22.

[21]. Musselman DR, Tate DA. Left coronary dominance due to direct continuation of the left anterior descending to form the posterior descending coronary artery. *Chest*. 1992; 102(1):319-20.

[22]. Akdimir R, Gunduz H, Ozhan H, Yazici M, Erbilien E, Yyan C. Simultaneous anterior and inferior myocardial infarction due to occlusion of the left anterior descending coronary artery. Turk J Med Sci 2004; 34:121–26.

[23]. Kuno T, Numasawa Y, Miyata H, et al. Impact of Coronary Dominance on In-Hospital Outcomes after Percutaneous Coronary Intervention in Patients with Acute Coronary Syndrome. Pasterkamp G, ed. PLoS ONE. 2013; 8(8):e72672. doi:10.1371/journal.pone.0072672.

[24]. Goldberg A, Southern D, Galbraith P.D, Traboulsi M, Knudtson M.L, Ghali W A. Coronary dominance and prognosis of patients with acute coronary syndrome. American Heart Journal Dec 2007; 154(6): 1116- 1122.

[25]. Zindrou, D.; Taylor, K. M. & Bagger, J. P. Coronary artery size and disease in UK South Asian and Caucasian men. Eur. J. Cardiothorac. Surg. 2006; 29(4):492-495.

[26]. Foley DP, Melkert R, Serruys PW. Influence of coronary vessel size on renarrowing process and late angiographic outcome after successful balloon angioplasty. Circulation 1994; 90:1239-51.

[27]. Cantor WJ, Miller JM, Hellkamp AS, Kramer JM, Peterson ED, Hasselblad V, Zidar JP, Newby LK, Ohman EM. Role of target vessel size and body surface area on outcomes after percutaneous coronary interventions in women. Am Heart J 2002; 144:297—302.

[28]. Elezi, S.; Kastrati, A.; Neumann, F.; Hadamitzky, M.; Dirschinger, J. & Schömig, A. Vessel Size and Long-Term Outcome after Coronary Stent Placement. Circulation. 1998; 98(18):1875-80.

[29]. Lewis CM, Dagenais GR, Friesinger GC and Ross RS. Coronary angiographic appearance in patients with left branch block. Circulation 1970; 41: 299-307.

[30]. Vlodaver Z, Amplatz K, Burchell HB and Edwards JE (1976) coronary heart disease. Clinical, angiographic and pathologic profiles. Springer Verlag, New York, pp 123-158. (Quoted by J. Reig Vilallonga).

[31]. Green GE, Bernstein S, Reppert EH. The length of the left main coronary artery. Surgery. 1967 Dec; 62:1021–24.

[32]. Johnson AD, Detwiler JH, Higgins CB. Left coronary artery anatomy in patients with bicuspid aortic valves. British Heart Journal. 1978; 40(5):489-493.

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