

*Original Article*

## Frequency in the Anomalous Origin of the Left Main Coronary Artery with Angiography in a Turkish Population

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We estimated the frequency of anatomic variations in origin of the left coronary artery in a Turkish population by analyzing the angiographic data of 10,042 consecutive adult patients undergoing coronary angiography. Among 10,042 adult patients, 5 (0.04%) patients (4 men and 1 woman, age range 40–74, median 58 years old) had anomalous origin of the left main coronary artery. The left main coronary artery arose from the right coronary sinus of Valsalva in 2 (0.019%) patients (both of them had a retro-aortic course), from above the left coronary sinus of Valsalva in 2 (0.019%) patients, and from above the non-coronary (posterior)-left coronary commissure in 1 (0.009%) patient. Anomalous origin of the left main coronary artery is potentially a serious condition, as it can lead to myocardial infarction and sudden cardiac death under physical exertion. Therefore, greater effort for early detection and surgical repair of this anomaly are warranted. The angiographic recognition of anomalous origin of this vessel may prove useful for physicians dealing with diagnosis and treatment of anomalies of the left main coronary artery.

**Key words:** left main coronary artery, anomalous origin, angiography

**T**he left main coronary artery (LMCA), which is usually larger than the right coronary artery, normally arises from the left coronary sinus of Valsalva. When the LMCA arises from outside the left aortic sinus, its origin and course may be as follows [1–4]:

(1) The LMCA may arise from the right sinus of Valsalva or the proximal right coronary artery. In that case, it may follow one the (a) septal course, (b) anterior free wall course, (c) retro-aortic course, or (d) interarterial course.

(2) The LMCA may arise from the non-coronary

(posterior) aortic sinus. Except for the ectopic origin, the anatomical course is normal [3, 5, 6].

(3) The LMCA may arise from the proximal part of the ascending aorta. A search within the proximal 2 cm of the ascending aorta usually reveals the anomalous orifice. Except for the high takeoff, distribution is normal [3].

(4) The LMCA may arise from the pulmonary trunk or pulmonary artery. Blood flow originates in a dilated right coronary artery and passes via collaterals to the left coronary artery, where it flows in a retrograde fashion into the pulmonary artery [7].

(5) If the left main trunk is absent, one of the following may occur: (a) Separate origin left anterior descending and circumflex coronary arteries may arise from the left sinus of Valsalva, with both of normal length and course

[2, 3, 5]; (b) The left circumflex coronary arteries may arise from the right sinus of Valsalva or right coronary artery and follow a course posterior to the aorta [3, 8–10]; (c) The left anterior descending coronary artery may arise from the right sinus of Valsalva or right coronary artery [2, 8–10] and follow either a septal course or an anterior free wall course; or (d) The left anterior descending coronary artery may arise from the non-coronary (posterior) aortic sinus, with its initial portion posterior to the aorta and following a course anteriorly toward its normal position [2].

The angiographic recognition of this vessel may be useful for physicians dealing with diagnosis and treatment of anomalous LMCA.

The aim of the study was to examine the anatomical patterns and frequency of occurrence of the anomalous LMCA coronary artery in the Turkish population.

### Materials and Methods

This study included 10,042 patients who underwent routine coronary arteriography at the Sani Konukoğlu Medical Center, Gaziantep, Turkey. All patients who underwent coronary arteriography from January 1999 to May 2001 were included. Indications for coronary angiography included anginal syndrome, palpitation, syncope, control of percutaneous transluminal coronary angioplasty and bypass surgery. Coronary angiography was performed by the Judkins femoral or Sones brachial technique in standard projections. This was primarily an adult coronary arteriographic population studied to determine whether coronary artery disease was present or absent. The databases of the cardiac catheterization laboratories of the catheterization reports were retrospectively analyzed, and cases with anomalous LMCA were selected for further assessment. Films selected for further assessment were reviewed by two independent investigators before being finally classified. The course of an anomalous artery was defined according to the guidelines of Ishikawa *et al.* [1] and Serota *et al.* [2]. Patients with separate ostia for the left anterior descending coronary artery and left circumflex artery in the left or right sinus of Valsalva and single type coronary artery were excluded. Patients with coronary anomalies occurring as part of congenital heart disease were also not included in the present study.

The mean age of the study population was 57 years, with a range of 27 years to 90 years. Sixty-eight percent were males and 32% were females; 70% had coronary

artery disease, 2% had rheumatic heart disease, 2% had congenital heart disease, 3% had miscellaneous heart disease and 23% had no organic heart disease according to invasive hemodynamic investigation.

### Results

In this study, the incidence of anomalous origin of the LMCA was 0.04% (5 out of 10,042 patients). The relevant clinical data are presented in Table 1. The patients who had anomalous origin of the LMCA consist of 4 men and 1 woman (age range 40–74, median 58 years old). The LMCA arose from the right coronary sinus of Valsalva (there were separate orifices for the right coronary artery and the LMCA) in 2 patients (Cases 1 and 2), (0.019%). In both cases the LMCA followed a posterior course (Figs. 1 and 2). The LMCA arose from above the left coronary sinus of Valsalva in 2 patients (0.019%) (Cases 3 and 4, Figs. 3 and 4). The LMCA arose from above the non-coronary (posterior)-left coronary commissure in 1 patient (0.009%) (Case 5, Figs. 5A, B).

The length of high takeoff of the LMCA arising from above the left or right sinus of Valsalva in 3 patients was less 1 cm, and none of them had aortic valvular anomaly.

### Discussion

In the literature, there are some retrospective studies to establish the incidence of different congenital coronary anomalies. As seen in Table 2, the incidence of anomalous LMCA in adults was 0.02–0.07% [3, 5, 9–12]. In our study, the incidence of LMCA anomaly was 0.04%, which agrees with the incidence reported elsewhere. The present angiographic research and other angiographic research reported in the literature involved only adults. The incidence of anomalous LMCA in infancy is higher than the incidence in adults because patients with LMCA arising from the pulmonary trunk may have died in infancy. If the patient survives the first year of life, he or she has a good chance to survive until adulthood: this fact may be related to the development of collaterals between the coronary artery originating from the pulmonary trunk and the coronary artery originating from the aorta [6].

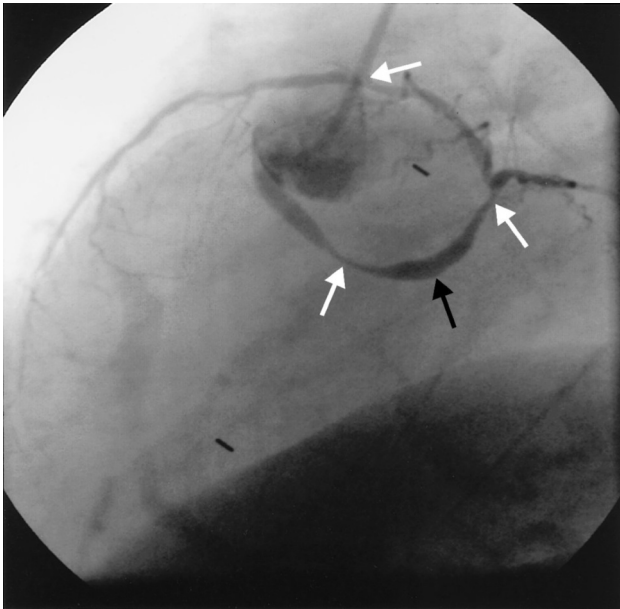
The LMCA arising from the right sinus of Valsalva is a potentially serious coronary artery anomaly.

The anomalous origin and proximal course of the LMCA from the right sinus of Valsalva may be associat-

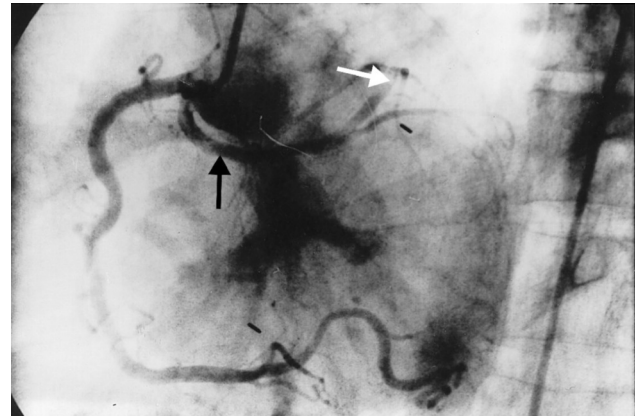
**Table 1** The clinical and cardiac catheterization data of the 5 patients in our series

| Patients | Age (years) /sex | Complaints   | Reason for evaluation | Electrocardiogram findings  | Cardiac catheterization and angiographic data  | Origin of left main coronary artery anomalous                            | Course of left main coronary artery anomalous | Co-existing disease                               | Management treatment |
|----------|------------------|--|-----------------------|---|--|--|---|---|----------------------|
| Case 1   | 74/F             | Chest pain, dyspnoea                                     | CAD                   | NSR, ST-dep in V <sub>2-6</sub> and D <sub>1-3</sub> , ST-ele in D <sub>1</sub> and aVL   | The stenosis of the LMCA (95%), LAD (95%, prox por), the RCA (90%, prox por)   | Arising from the right sinus of Valsalva                                 | Retro-aortic course                           | CAD, Heart and kidney failures, Diabetes mellitus | Bypass surgery       |
| Case 2   | 57/M             | Continued post MI angina                                 | CAD                   | NSR, ST-ele in V <sub>1-3</sub> , D <sub>1</sub> and aVL, T-neg in D <sub>1</sub> and aVL, T-biphasic in V <sub>1-3</sub>       | The stenosis of the LAD (95%, prox por), rudiment LCx  | Arising from the right sinus of Valsalva                                 | Retro-aortic course                           | CAD   | Bypass surgery       |
| Case 3   | 40/M             | Palpitation on exertion                                  | CAD                   | NSR, T-neg (7 mm) in V <sub>1-3</sub>   | LAD was recanalising (after D <sub>1</sub> branch)   | Arising from above the left sinus of Valsalva                            | Normal course                                 | CAD   | Medical therapy      |
| Case 4   | 46/M             | Continued post MI angina                                 | CAD                   | NSR, Pathologic Q, ST-ele and T-biphasic in D <sub>2-3</sub> and aVF, T-sharp in V <sub>2,3</sub> and T-neg in V <sub>5-6</sub> | The stenosis of the LMCA (30%), LAD (100%, prox por), the RCA (95%, after acute margin) and the rudiment LCx<br>Left ventricle was global hypokinetic                                    | Arising above the left sinus of Valsalva                                 | Normal course                                 | CAD   | Bypass surgery       |
| Case 5   | 73/M             | Chest pain, dyspnoea, palpitations, perspiration at rest | CAD                   | NSR, ST-ele in V <sub>1-4</sub> , and ST-dep in D <sub>1-2</sub> , aVF  | The stenosis of the LAD (100%, prox por), the LCx (95%, after OM <sub>2</sub> branch), the acute margin of the RCA (50%) and the orificium LMCA<br>Diskinetic anterolateral area at apex | Arising from above the non-coronary (posterior)-left coronary commissure | Normal course                                 | CAD and grade one mitral valvular insufficiency   | Bypass surgery       |

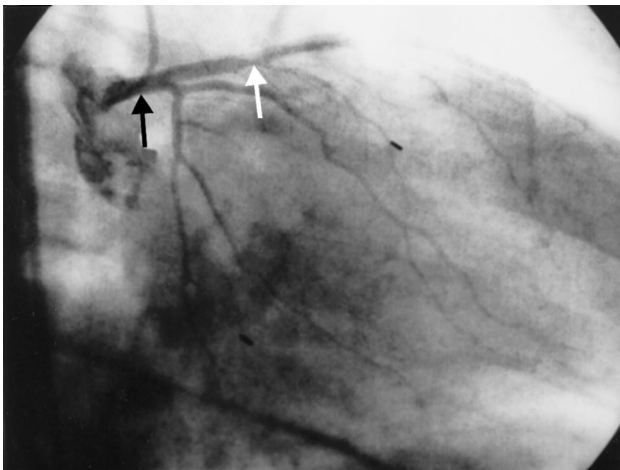
CAD, coronary artery disease; dep, depression, ele: elevation; LAD, left anterior descending coronary artery; LMCA, left main coronary artery; MI, myocardial infarction; neg, negative; NSR, normal sinus rhythm; por, portion; prox, proximal; RCA, right coronary artery.



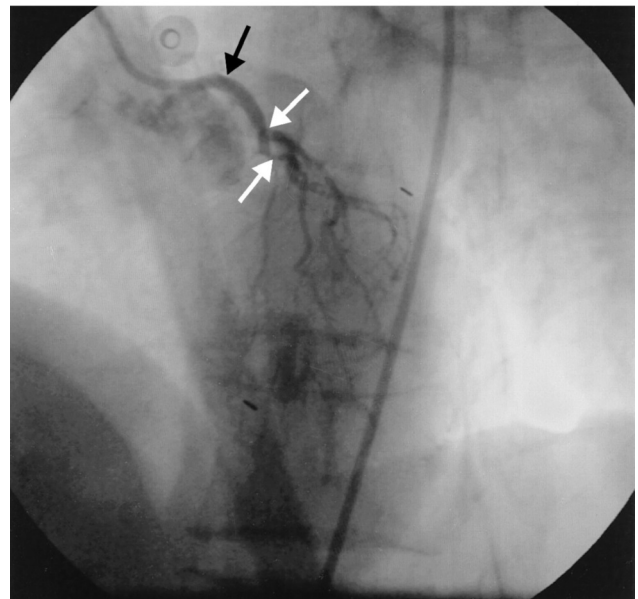
**Fig. 1** Case 1: Ectopic origin of the left main coronary artery (LMCA) (black arrow) from the right coronary sinus of Valsalva, retro-aortic course. The LMCA passes posterior to the aorta with a caudal-posterior loop before dividing into the left anterior descending coronary artery and the left circumflex coronary artery. Stenosis of the LMCA was observed in 2 areas (95% and 90%), the left circumflex coronary artery was rudimentary and there was 95% stenosis in the left anterior descending coronary artery (the stenotic area is indicated with white arrows). Lateral projection.



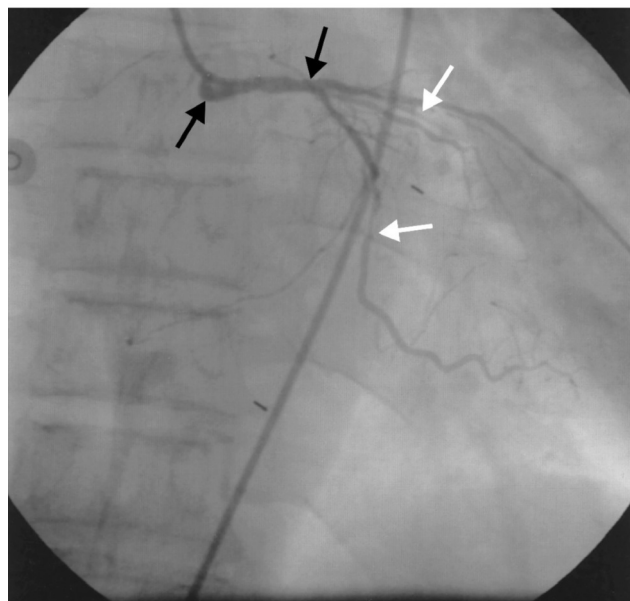
**Fig. 2** Case 2: Ectopic origin of the left main coronary artery (black arrow) from the right coronary sinus of Valsalva, retro-aortic course. The left main coronary artery passes posterior to the aorta with a caudal-posterior loop before dividing into the left anterior descending coronary artery and the left circumflex coronary artery. Severe atherosclerosis was observed with a 95% proximal left anterior descending lesion (white arrow). Left anterior oblique projection.



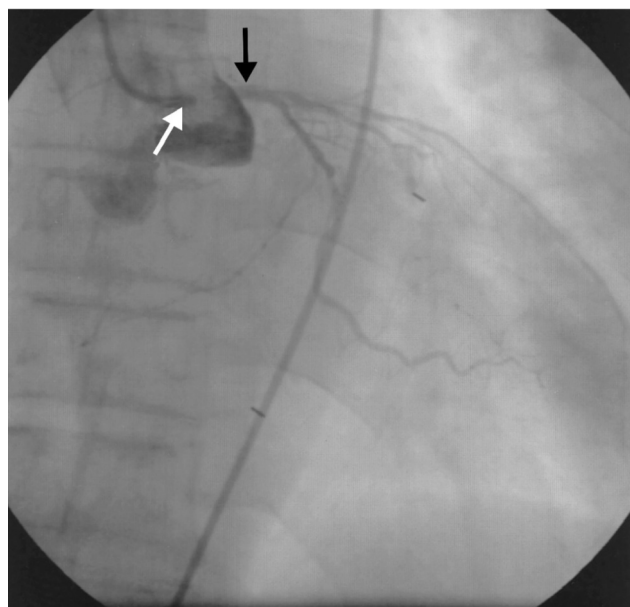
**Fig. 3** Case 3: Ectopic origin of the left main coronary artery (black arrow) from above the left coronary sinus of Valsalva. The origin of the left main trunk was the closed posterior (non-facing) coronary sinus, the left main trunk was longer and the catheter position was inverted. The left anterior descending coronary artery was 50% stenotic (white arrow). Right anterior oblique projection.



**Fig. 4** Case 4: Ectopic origin of the left main coronary artery (black arrow) from above the left coronary sinus of Valsalva, normal course. Severe atherosclerosis was found in 100% of the proximal left anterior descending lesion, and 30% stenosis was found in the left main coronary artery (white arrows). Left anterior oblique projection.



A



B

**Fig. 5** Case 5: Ectopic origin of the left main coronary artery from above the non-coronary (posterior)-left coronary commissure, normal course. The black arrow shows the origin of the left main trunk; the white arrow shows the end of the catheter. Sclerosis was documented with a 100% proximal left anterior descending coronary artery, and 95% stenosis in the left circumflex coronary artery (white arrow). **A**, Left anterior oblique projection. **B**, Left anterior oblique projection.

**Table 2** The incidence of anomalous left main coronary artery (LMCA) in a population

| Authors           | Number of Patients | Number of Anomalous lmca | Angiographic incidence of anomalous lmca (%) | Population |
|-------------------|--------------------|--------------------------|--|------------|
| Garg [10]         | 4100               | 1                        | 0.02*  | Indian     |
| Kaku [9]          | 17731              | 5                        | 0.02***                                      | Japanese   |
| Kardos [5]        | 7694               | 6                        | 0.07   | Hungarian  |
| Cieslinski [11]   | 4016               | 1                        | 0.02**                                       | German     |
| Iniguez Romo [12] | 4313               | 1                        | 0.02*  | Spanish    |
| Yamanaka [3]      | 126595             | 49                       | 0.03   | American   |
| Our findings      | 10042              | 5                        | 0.04   | Turkish    |

\*, Cases with high takeoff of coronary arteries were excluded, \*\*, Cases with an origin from the non-coronary sinus of Valsalva and high takeoff of coronary arteries were excluded, \*\*\*, Cases with anomalous origin of the coronary artery from the pulmonary trunk were excluded.

ed with an increased risk of myocardial infarction and sudden death [13]. The anomalous origin of the LMCA has been investigated frequently because of reports linking this congenital anomaly with sudden death in young people [4, 13, 14, 15].

Anomalous origin of the right coronary artery (RCA) above the left sinus of Valsalva is exceedingly rare. In the literature, Yamanaka and Hobbs [3] reported ectopic origin of the LMCA from the ascending aorta. They found the incidence of ectopic origin of LMCA from the ascending aorta was 0.013%, while Kardos *et al.* [5] observed no cases of LMCA arising from the ascending aorta in their series. In this study, the LMCA arose from above the non-coronary (posterior)-left coronary commissure in 1 (0.01%) patient and from above the left coronary sinus of Valsalva in 2 (0.01%) patients. The length of high takeoff of the LMCA arising from above the left sinus of Valsalva and the non-coronary (posterior)-left coronary commissure in 3 patients was less than 1 cm, and none of them had aortic valvular anomaly. All of them had serious coronary lesions. In addition, cardiac surgeons should be careful to avoid accidentally cross-clamping or transecting the vessel during surgery [3].

We observed that all of our cases with LMCA anomalies had severe sclerosis of the LMCA and/or right coronary artery and their branches. Taylor *et al.* [4] found that the incidence of coronary artery disease was 40 times higher in the > 30 year age group who had anoma-

lous origin of the coronary arteries. Liu *et al.* [16] had postulated that the junction point of the bound portion of the anomalous artery and the free portion as it wraps around the aorta is on area susceptible to lipid accumulation. The relationship between coronary artery obstructive disease and congenital coronary artery anomalies may be synergistic.

Anomalous origin of the LMCA is potentially serious, as it can lead to myocardial infarction and sudden cardiac death under physical exertion. Further investigation of young patients, particularly athletes with palpitations and/or syncope, may be advisable to exclude anatomical abnormalities of the coronary arteries as a rare underlying cause, and to avoid possible sudden cardiac death. A greater effort for early detection and surgical repair of this anomaly is warranted. The angiographic recognition of this vessel may be useful for physicians dealing with diagnosis and treatment of the LMCA.

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