

atrial level in all 6 cases; however, only 1 had significant oxygen step-up, with $Qp/Qs = 1.4$ during the cardiac catheterization study.

The efficacy of PTMC is well documented. However, it has some risks of complications.²⁻⁴ Complications frequently reported include mortality, emergency surgery, cardiac tamponade, systemic thromboembolism, mitral regurgitation and atrial septal defect. The complication rates of systemic thromboembolism range from 0 to 4%.²⁻⁴ Hence, left atrial thrombus was considered as an absolute contraindication for PTMC. However, all previous studies depend on transthoracic echocardiography to detect left atrial thrombus.²⁻⁴ The diagnostic accuracy of transthoracic echocardiography to detect left atrial thrombus is not satisfactory.^{5,6} Because transesophageal echocardiography improves the diagnostic sensitivity of left atrial thrombus, more patients with MS would be found to have left atrial thrombus. The issue of whether patients with small and fixed thrombus confined to the left atrial appendage should be denied the potential benefits of PTMC is worth examining. Our preliminary experience may shed some light on this crucial point. All 6 cases in this series had successful PTMC without clinically evident thromboembolic complication.

PTMC with the Inoue balloon catheter has lower thromboembolic rates (0% to 1.4%) than do other balloon catheters (3 to 4%) in the literature.²⁻⁴ The special character of the Inoue balloon catheter may explain the lower rates of thromboembolic complication. First, its coiled

left atrial guidewire can prevent the catheter from entering the left atrial appendage (the most frequent location of thrombus). Second, its flow-directed passage from the left atrium to left ventricle can minimize manipulation of the catheter in the left atrium.

From our experience, thrombus in the left atrial appendage is not an absolute contraindication for PTMC. In selected patients with MS who have small and fixed left atrial appendage thrombus, PTMC could be carefully performed with the Inoue balloon catheter with acceptably low complication risks.

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The Four Subtypes of Anomalous Origin of the Left Main Coronary Artery from the Right Aortic Sinus (or from the Right Coronary Artery)

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Most published reports of coronary arterial anomalies concern a single patient or only a small group of patients. Although much good and useful information, of course, can be derived from the study of a single patient, multiple cases of a major coronary anomaly are required to observe the various subgroups of a single major anomaly. We have studied at necropsy 17 patients in whom the left main coronary artery (LMCA) arose from either the right aortic sinus or the most proximal portion of the right coronary artery.¹⁻⁵ After its origin, the LMCA coursed to the left side of the heart by 1 of 4 routes, and the clinical consequences of such courses are described in this report.

Pertinent clinical and necropsy findings in the 17 patients are summarized in Table 1, and the 4 subtypes are illustrated in Figure 1. In 2 patients (12%) (cases 1 and 2 [Table 1]), the anomalously arising LMCA coursed anterior (group A) to the right ventricular outflow tract to reach the anterior sulcus (the anterior portion of the heart immediately anterior to the ventricular septum), where it then divided into the left anterior de-

scending and left circumflex coronary arteries.⁵ In neither patient did the coronary anomaly appear to have caused cardiac dysfunction or myocardial ischemia.

In 9 patients (53%) (cases 3 to 11), the anomalously arising LMCA coursed in between (group B) the ascending aorta and pulmonary trunk before reaching the anterior sulcus.²⁻⁴ The ostium of the LMCA was slit-like in 8 patients. In 7 of the 9 patients death was attributed to the coronary anomaly: sudden outside the hospital in 6, and secondary to severe intractable congestive heart failure (the result of a previous large acute myocardial infarct that had healed) in 1 (case 9).

In 2 patients (12%) (cases 12 and 13), the anomalous LMCA coursed within the crista supraventricularis muscle (group C) behind the right ventricular outflow cavity before reaching the anterior sulcus, and then dividing into the left anterior descending and left circumflex coronary arteries.¹ Neither patient ever had evidence of myocardial ischemia or cardiac dysfunction.

In 4 patients (23%) (cases 14 to 17), the anomalous LMCA coursed dorsal (group D) to the ascending aorta before reaching the usual area of bifurcation into the left anterior descending and left circumflex coronary arteries.^{5,6} Although 2 of the 4 patients died from cardiovas-

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TABLE 1 Clinical and Morphologic Findings in 17 Patients with Anomalous Origin of the Left Main Coronary Artery from the Right Coronary Artery or the Right Aortic Sinus

Case	Age (yr) & Sex	Origin of LMCA	Anomaly Group*	Length of LMCA (cm)	Death			Cause of Death	Length of RCA > LCCA	Slit-Like Ostium	No. of Major CAs > 75% ↓ in CSA by Plaque	LV Scar (1 to 3+)	HW (g)
					AP	SD	Outside Hospital						
1	22 M	RAS	A	4.5	0	+	+	HC	+	0	0	0	870
2	44 F	RAS†	A	3.0	+	+	+	Trauma	+	0	0	0	255
3	13 F	RAS	B	1.1	0	+	+	Coronary anomaly	+	+	0	0	210
4	14 M	RAS	B	1.2	0	+	+	Coronary anomaly	+	+	0	0	370
5	14 M	RAS	B	—	0	+	+	Coronary anomaly	—	+	0	0	380
6	19 M	RAS	B	1.1	0	+	+	Coronary anomaly	+	+	0	0	325
7	29 M	RAS	B	—	+	+	+	Coronary anomaly	0	+	0	+	350
8	39 F	RAS	B	—	0	+	+	Coronary anomaly	0	+	0	0	220
9	64 F	RAS	B	2.4	+	0	0	Coronary anomaly	+	+	0	+++	510
10	81 M	RAS	B	2.0	0	+	+	Trauma	+	0	0	0	420
11	50 F	RAS†	B	—	0	+	+	Atherosclerotic CAD	+	0	3	+++	650
12	34 M	RAS	C	4.7	0	0	+	Trauma	+	0	0	0	330
13	48 M	RAS	C	4.5	0	+	+	Trauma	+	0	0	0	550
14	32 M	RAS	D	3.3	0	+	+	Trauma	0	0	0	0	325
15	45 M	RAS	D	4.5	+	+	+	Atherosclerotic CAD	+	0	1	+++	580
16	57 F	RAS	D	3.6	0	0	+	Opiate addiction‡	+	0	0	0	300
17	69 M	RCA	D	3.0	0	0	0	Forme fruste Marfan	+	0	0	0	685

*See Figure 1 for description.

†Common ostium of both RCA and LMCA.

‡Complications arising from the addiction.

AP = angina pectoris; CA = coronary artery; CAD = coronary artery disease; CSA = cross-sectional area; HC = hypertrophic cardiomyopathy; HW = heart weight; LCCA = left circumflex coronary artery; LMCA = left main coronary artery; LV = left ventricular; RAS = right aortic sinus; RCA = right coronary artery; SD = sudden death; + = present or positive; 0 = absent or negative; — = no information available.

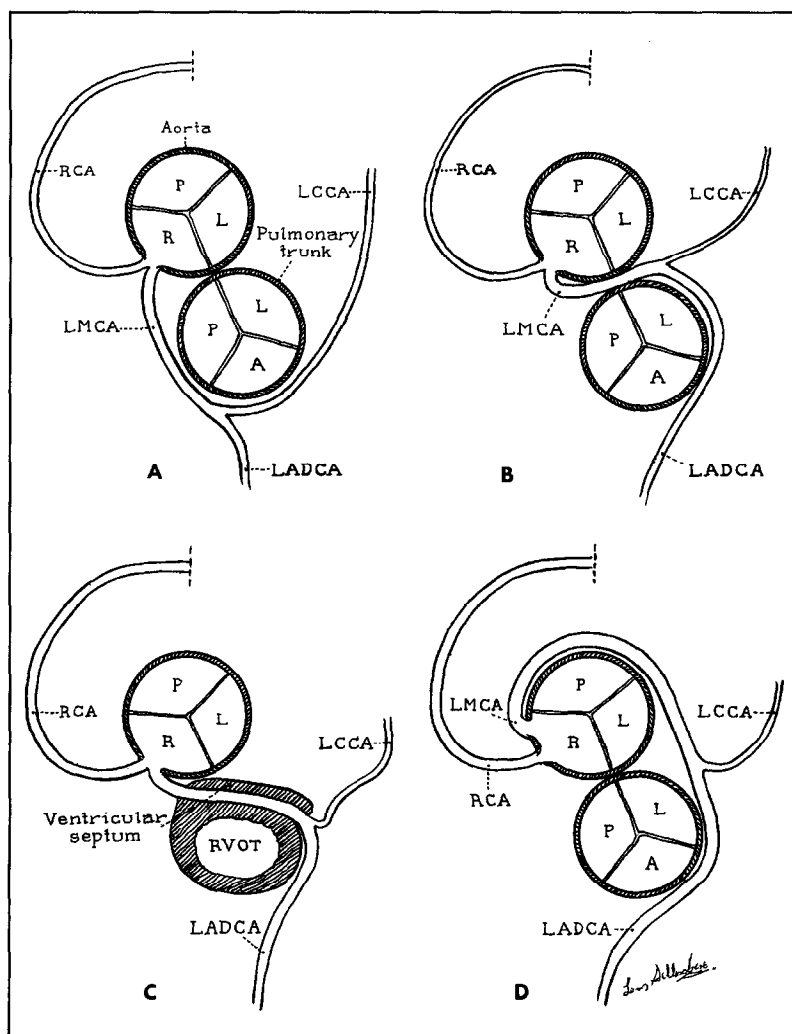


FIGURE 1. Diagram showing the 4 subtypes of anomalous origin of the left main coronary artery (LMCA) from the right aortic sinus. A = anterior; L = left; LADCA = left anterior descending coronary artery; LCCA = left circumflex coronary artery; P = posterior; R = right; RCA = right coronary artery; RVOT = right ventricular outflow tract.

cular disease (atherosclerosis in 1, and Marfan-type aortic disease in the other), in none could the cardiac problems be attributed to the coronary anomaly.

This brief report indicates that if an anomalously arising LMCA courses anterior (group A) to the right ventricular outflow tract, behind the right ventricular outflow tract (infracristal) (group C) or dorsal (group D) to the ascending aorta, symptoms of cardiac dysfunction or myocardial ischemia do not result. In contrast, if the anomalously arising LMCA courses between (group B) the pulmonary trunk and ascending aorta, symptoms of myocardial ischemia usually occur, and death is a frequent consequence.

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Congenital Hypoplasia of Both Right and Left Circumflex Coronary Arteries

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When the right coronary artery is dominant, i.e., it courses to the crux of the heart, the left circumflex coronary artery is usually quite small and therefore may

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be considered hypoplastic (Figure 1). Conversely, when the left circumflex is the dominant coronary artery, i.e., it courses to the crux of the heart, the right coronary artery is usually small and therefore may be considered hypoplastic (Figure 1). Hypoplasia of both right and left circumflex coronary arteries in the same heart, however, is a rare occurrence (Figure 1). Examination of 3,400 hearts during the last 8 years disclosed at least 8 to have hypo-

FIGURE 1. Diagram showing graphic definitions of dominance and hypoplasia. The 8 patients described had right and left circumflex (LC) coronary arteries similar to those depicted in the bottom right diagram. LAD = left anterior descending; LM = left main coronary artery.

