

## Case Report

# Total Occlusion of the Left Main Coronary Artery: Clinical and Catheterization Findings\*

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**Summary:** In this report clinical and angiographic data on three patients with total occlusion of the left main coronary artery is presented. Two of our cases demonstrated rich collateralization with good preservation of left ventricular (LV) function. The third case, with initial subtotal occlusion and no collaterals, sustained a severe anterolateral myocardial infarction (MI) responding to the use of the intra-aortic balloon pump (IABP).

This report is consistent with the findings of others who suggest the possible beneficial effect of collaterals in preserving myocardial contractility in this unusual situation. We suggest that the IABP may be of benefit in patients with total occlusion of the left main coronary artery and sparse collaterals who remain unstable and cannot be operated on immediately.

**Key words:** left main coronary artery obstruction, collateral vessels, intra-aortic balloon pump

## Introduction

Total occlusion of the left main coronary artery (LMCA) due to atherosclerosis is an unusual entity with a reported incidence of 0.76% in patients undergoing revascularization surgery. This report reviews the clinical, hemodynamic, and angiographic findings in three patients with total occlusion of the left main coronary artery secondary to atherosclerosis, and the possible beneficial use of the intra-aortic balloon pump (IABP).

## Case Reports

### Case 1

A 39-year-old male was found on routine ECG to have changes consistent with an anteroseptal myocardial infarction when compared to a previous tracing. A graded exercise tolerance test performed at another hospital using the Bruce protocol revealed 3-mm ST depression at 12 min with a heart rate of 144 beats/min and epigastric aching. This same type of epigastric aching sensation had been related to exercise with increasing frequency over the past 1-2 months. Risk factors for atherosclerotic heart disease (ASHD) included cigarette smoking, one pack/day for 20 years, and adult onset of diabetes mellitus, diagnosed in 1977 and controlled by dietary discretion. Physical exam was normal with a blood pressure of 120/70 and a pulse of 70. The electrocardiogram showed an antecedent anteroseptal myocardial infarction. The patient's chest x ray was normal.

At the time of cardiac catheterization the cardiac index was 3.7 l/min/m<sup>2</sup> with a resting left ventricular end-diastolic pressure (LVEDP) of 15 mmHg. Left ventriculography demonstrated anterior hypokinesis with an ejection fraction of 50%. Selective coronary arteriography demonstrated total occlusion of the proximal left main coronary artery

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with no antegrade fill. The right coronary artery demonstrated 80% obstruction in the midportion with retrograde fill of the circumflex and left anterior descending coronary arteries (Fig. 1). The morning after catheterization, the patient was taken to the operating room where three saphenous vein bypass grafts were placed in the posterior descending, circumflex, and left anterior descending coronary arteries. The postoperative course was uncomplicated. Six weeks postoperatively a repeat graded exercise tolerance test was performed. The patient was asymptomatic without ECG

changes after 11 min of exercise on a Bruce protocol reaching a heart rate of 170 beats/min (Table I).

## Case 2

A 48-year-old male with crescendo angina of 3 weeks duration sustained an acute nontransmural myocardial infarction documented by ECG, enzymes, and technetium pyrophosphate scan. He was placed on propranolol hydrochloride (Inderal®) and isosorbide dinitrate (Isordil®) but continued to have pain. Electrocardiogram showed ST abnormalities in the lateral leads but no pathologic Q waves. Physical exam revealed a blood pressure of 160/80, a pulse of 70, and atrial gallop. The patient's chest x ray was normal.

At cardiac catheterization there was evidence of decreased LV compliance with a resting LVEDP of 30 mmHg. According to LV angiography there was no localized hypokinesis and the ejection fraction was 50%. There was total obstruction of the left main coronary artery. The right coronary artery was normal with retrograde flow to the left anterior descending and circumflex coronary arteries.

A graded exercise tolerance test using the Bruce protocol showed 2-mm ST depression after 3 min with angina and a maximum heart rate of 120 beats/min.

Three-vessel saphenous vein bypass surgery was performed without complications and the patient had an uncomplicated postoperative course. A graded exercise tolerance test was performed 7 weeks after surgery using a Bruce protocol. He exercised for 7 min, reaching a heart rate of 150 beats/min which is 88% of his age-corrected predicted maximum. He had no angina and there were no ischemic ST changes noted (Table I).

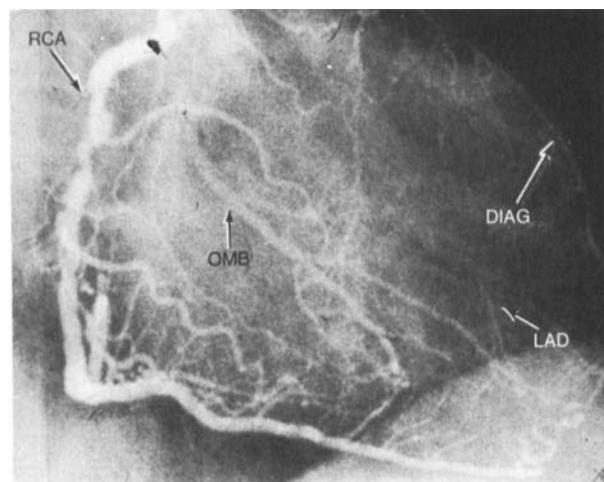


FIG. 1 Selective right coronary arteriography in patient 1 in a 30° right anterior oblique projection showing collaterals with retrograde fill of the LAD and circumflex systems. RCA, right coronary artery; OMB, obtuse marginal branch; DIAG, first diagonal; LAD, left anterior descending coronary artery.

TABLE I Clinical and angiographic patient data

Age and sex	Angina		ECG	CXR	GXT	EF (%)	Operation	Time postop (weeks)	Follow-up	
	NYHA class	Duration							GXT	NYHA class
Case 1 39, M	III	2 months	Antero-septal MI	N	Bruce protocol 12 min; 3-mm ST depression	50	3-vessel CABG	6	Bruce protocol 11 min; no ST changes	I
Case 2 48, M	IV	3 weeks	Nonspecific ST-T changes	N	Bruce protocol 3 min; 2-mm ST depression	50	3-vessel CABG	7	Bruce protocol 7 min; no ST changes	I
Case 3 39, M	IV	2½ months	Antero-lateral MI	N	Bruce protocol 4 min; 4-mm ST depression	32	3-vessel CABG	6	Modified Bruce protocol 18 min; no ST changes	I

Abbreviations: NYHA, New York Heart Association; CXR, chest x ray; GXT, graded exercise tolerance testing; EF, ejection fraction; MI, myocardial infarction; N, normal; CABG, coronary artery bypass grafts

### Case 3

A 39-year-old male with a 2½-month history of angina underwent a graded exercise tolerance test which demonstrated 4-mm ST depression after 4 min according to the Bruce protocol. His risk factors included a smoking history of three packs/day for 10 years, as well as a history of hypertension since 1972. His medications included Inderal® (80 mg/d) and Isordil® (5 mg sublingually q 4 h). Physical exam revealed a blood pressure of 110/80 with a pulse of 80 and a normal cardiovascular exam. The resting electrocardiogram, chest x ray, and echocardiogram were within normal limits.

At the time of cardiac catheterization, the cardiac index was 3 l/min/m<sup>2</sup> and the LVEDP was 12 mmHg. Left ventriculography demonstrated mild hypokinesis of the anterior wall but a normal ejection fraction of 65%. Selective coronary arteriography demonstrated a 90% obstruction of the left main coronary artery with only trivial irregularities in the left anterior descending coronary artery (LAD) and circumflex coronary arteries. There was no retrograde fill. The right coronary artery was normal. Approximately 6 h following the cardiac catheterization the patient sustained an acute transmural anterolateral myocardial infarction and was treated with intravenous nitroglycerin and an intra-aortic balloon pump. His post-MI course was complicated by congestive heart failure and the intra-aortic balloon was removed after 3 d. He had no further episodes of angina, and approximately 4 weeks post-MI, repeat cardiac catheterization was performed. The LVEDP was 23 mmHg. Left ventriculography demonstrated anterolateral hypokinesis with an ejection fraction of 32%. Selective coronary arteriography demonstrated total occlusion of the left main coronary artery (Fig. 2). The left anterior descending and circumflex branches filled retrogradely from the right coronary artery. Immediately following the catheterization, saphenous bypass



FIG. 2 Selective left coronary arteriography in patient 3 in the shallow right anterior oblique projection showing total occlusion of the left main coronary artery (LMCA) just distal to its origin.

grafts were placed to the left anterior descending, the diagonal, and the obtuse marginal coronary arteries. The patient did well postoperatively and returned to the hospital 6 weeks later for follow-up evaluation. At this time he had no further angina and on graded exercise testing, using a modified Bruce protocol, the test was terminated due to exhaustion at 18 min (4.0 m/h, 10% grade, 10 metabolic equivalent units) after reaching a heart rate of 150 beats/min with a normal blood pressure response and no ST-T wave changes. The patient is presently asymptomatic and taking no medications (see Table I).

### Discussion

Significant disease (>50% narrowing) of the left main coronary artery is reported in approximately 5% of patients undergoing coronary arteriography, while total occlusion of the left main coronary artery is an infrequent finding (Cohen and Gorlin, 1975; Lavine *et al.*, 1972).

Valle *et al.* (1979) reported that 4 of 948 patients undergoing coronary angiography had total left main coronary occlusion, an incidence of 0.42%, while Crosby *et al.* (1979) reported a 0.76% incidence of total left main coronary occlusion in patients undergoing revascularization surgery between 1972 and 1978. Frye *et al.* (1977) reported an incidence of 0.067% of total left main coronary artery occlusion in 4 of 6,000 patients undergoing coronary arteriography between 1966 and 1975. At the Cleveland Clinic 63,500 coronary angiographies revealed 14 patients with completely occluded LMCA (Valle *et al.*, 1979).

There is much variability in the clinical course of patients with total occlusion of the LMCA reported in the literature. This includes angina varying from a relatively short duration—as in our three cases—to an extremely long duration of anginal symptoms (average 11 years) in the report by Crosby *et al.* (1979). Graded exercise tolerance tests obtained preoperatively were all markedly abnormal, in agreement with other reports. Angiographic assessment showed retrograde filling of both the LAD and circumflex systems from the right coronary artery in all cases as well as total left main coronary artery proximal obstruction.

There has been much discussion concerning the importance of the human coronary collateral circulation, especially in regard to preserving myocardial contractility (Frye *et al.*, 1977; Hamby *et al.*, 1976; Helfant *et al.*, 1971; McGregor, 1975; Valle *et al.*, 1979). An editorial by McGregor (1975) reviewed studies for and against the functional importance of the coronary collateral circulation in preserving myocardial function. He concluded that there is direct evidence that collateral vessels can at least partially compensate for the loss of normal coronary flow, and it is not reasonable to infer that they may be functionless from the angiographic evidence. Two of our cases with collateral flow demonstrated mildly reduced ejection fractions. Case 3, which failed to show collateral flow preinfarction, had evidence of significant LV dysfunction (ejection fraction of 32%) after sustaining a massive MI. This is consistent with the finding of Goldberg

*et al.* (1978) who published findings of relatively small decreases in LV contractility in three patients with total LMCA occlusion and extensive collaterals from the right coronary artery in contrast to more severely depressed LV contractility in three similar patients with sparse collaterals. It may be that well-developed collateral circulation from the right coronary artery is sufficient both to prevent massive myocardial infarction and to preserve LV function. Our three cases, although sustaining myocardial infarction, underwent coronary revascularization without complications and demonstrated a marked improvement in exercise tolerance without evidence of ischemia postoperatively.

The rarity with which total LMCA occlusion is seen suggests this may be a terminal event in many patients in whom it occurs. However, this was not supported by Bulkley and Roberts (1976) who reviewed the postmortem findings in 152 patients with varying degrees of left main coronary artery narrowing. They failed to find a single case of complete occlusion of the left main coronary artery. Survival may be dependent on the rate at which occlusion of the LMCA occurred, as suggested by the experiments of Khouri *et al.* (1971). Gradual development of occlusion may allow for functional collaterals to develop. Survival in one of our patients (case 3) supports this concept in that sudden occlusion of the LMCA in the absence of collateral flow resulted in a massive myocardial infarction requiring IABP assist.

Cooper *et al.* (1977) reported that preoperative IABP usage is reasonable supportive adjunct in surgery for left main coronary stenosis. The rationale for this is the augmentation of impaired myocardial blood flow and decreased afterload in a compromised ventricle. Our case 3 probably sustained marked benefit from the use of the IABP. Although in our case it was not used preoperatively, the rationale for its use remains the same. This suggests that the IABP may be of benefit in patients with total occlusion of the LMCA and sparse collaterals who are unstable and cannot be immediately operated on.

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