CASE REPORTS

Anomalous Left Coronary Artery from Pulmonary Artery
An Eight Year Angiographic Follow-up after Saphenous Vein Bypass Graft

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SUMMARY
We have presented a 7-week and 8-year postoperative angiographic follow-up of a 36-year-old man who had an anomalous left coronary artery arising from the pulmonary artery and who had an aortocoronary bypass graft to the left anterior descending artery. The late study showed 1) a large, well-functioning patent graft, 2) lack of significant postoperative change in the size of the right coronary artery and 3) new collateral vessels between the distal left anterior descending and left circumflex coronary arteries and persistence of collateral vessels between the distal right and left circumflex coronary arteries. This report is the longest known angiographic follow-up of a patient with this anomaly who has been treated with bypass surgery.

Additional Indexing Words:
Collateral vessels

THE SURVIVAL OF SOME PATIENTS with an anomalous origin of the left coronary artery to adulthood has been explained by the persistence of large collaterals associated with a variable amount of left-to-right shunt into the pulmonary artery.1-3 The high risk of sudden death in adult patients with this condition1-4 has resulted in prompt surgical intervention when the anomaly is discovered.4-7 Angiographic follow-up of operated adult patients has been limited to less than one year. This report is an 8-year follow-up of a 36-year-old man who has had a saphenous vein bypass graft to his anomalous left coronary artery and who has had both 7-week and 8-year postoperative angiographic appraisals of his graft and coronary artery anatomy.

Case History
This 36-year-old caucasian man was known to have a heart murmur since the age of 5. He was asymptomatic until February 1954 (age 17) when he was hospitalized elsewhere for left substernal chest pain and palpitations following severe exertion. A thrill was felt at the lower left sternal border and systolic and diastolic murmurs maximal at the 4th left interspace were heard. Left ventricular hypertrophy and left axis deviation were present on the electrocardiogram. The chest X-ray revealed moderate cardiomegaly. Cardiac catheterization revealed normal right and left heart pressures with a 16.6% left-to-right shunt at the pulmonary artery level. He was discharged with the diagnosis of possible aorto-pulmonary window. In September 1958 (age 21) he had a second cardiac catheterization because of fatigue and chest pain on exertion and persistent palpitations. The findings were the same as at age 17 except that the shunt had increased to 26.6%.

In June 1966 (age 29) he was referred to this hospital for further evaluation. At that time he complained of fatigue, shortness of breath and mild left substernal chest pain on severe exertion with rare episodes of palpitations. A thrill was felt at the 4th left interspace. A grade II/VI systolic murmur and a grade II/VI diastolic murmur, both maximal at the 4th left interspace, were heard. Both heart sounds were normal. A right and left cardiac catheterization was performed and an anomalous left coronary artery arising from the main pulmonary artery was found. The right coronary artery was dilated and tortuous (fig. 1) filling large collaterals to the left circumflex and left anterior descending...
coronary arteries. Hemodynamic findings were unchanged from September 1958 and the shunt was noted to be 25%. In July 1966 (age 29) he had open heart surgery. The left coronary artery was ligated at its origin. The vessel was divided distal to the origin of the left circumflex artery and an aortocoronary saphenous vein bypass graft was anastomosed end-to-end to the proximal left anterior descending coronary artery. Postoperative course was uneventful and the patient left hospital 15 days later. Cardiac examination prior to discharge revealed persistence of both the systolic and diastolic murmurs.

In August 1966 (age 29), 7 weeks after surgery, he returned to hospital for evaluation of his graft status. He was asymptomatic. Cardiac auscultation was unchanged from postoperative examination. An aortic root injection revealed a large patent graft with good flow and a right coronary artery which was the same size as before operation (fig. 2 left). The large collaterals between the distal right and left circumflex arteries had not regressed (fig. 2 right).

In April 1974 (age 36) he was readmitted for a late evaluation of his graft. He was working full time, doing heavy labor without shortness of breath or fatigue on exertion. A systolic and a diastolic murmur were present at the left upper intercostal space. Electrocardiographic and vectorcardiographic analyses showed left ventricular hypertrophy with secondary ST-T abnormalities and left axis deviation. Selective right coronary arteriography showed a dilated, tortuous artery approximately the same size as that seen in

Figure 1
Preoperative angiogram, 1966. Semi-selective injection of the right coronary artery in the right anterior oblique position (45°). This injection shows a large tortuous right coronary artery (RCA). The technical quality of this photograph is not sufficient to show the collateral circulation.

Figure 2
Postoperative angiogram at seven weeks. Left) Early phase. The vein graft (VG) is widely patent and is anastomosed to the proximal portion of the left anterior descending artery (LAD) proximal to a large first septal branch (S1). There is antegrade flow through the left anterior descending artery but no antegrade flow in the left circumflex artery. The right coronary artery (RCA) remains tortuous, dilated and the same caliber as before operation. Right) Late phase. This photograph shows numerous opacified collateral vessels (arrows) of the distal right coronary artery filling the distal left circumflex (Cx) and its first high marginal branch (Marg). There is retrograde filling of these vessels to the level of the proximal stump of the left coronary artery (LCA).
1966 (fig. 3 top) and persistence of large collaterals between the distal right coronary and left circumflex arteries (fig. 3 bottom). There was competition of flow to the first marginal branch of the left circumflex artery between collateral vessels from the right coronary and left anterior descending coronary arteries visible on the cineangiogram. Selective graft injections demonstrated a large patent graft with good anterograde flow into the left anterior descending artery (fig. 4 top). The left circumflex system filled from distal collateral vessels of the left anterior descending artery by retrograde flow (fig. 4 bottom).

**Discussion**

Detection of an anomalous left coronary artery in an adult is an indication for surgery because of the high risk of sudden death. Aortocoronary bypass graft to the left main coronary artery after its separation from the pulmonary artery is the treatment of choice for adults at the present time. It has a low operative mortality rate and provides the patient with a dual coronary circulation. Late angiographic follow-up.

**Figure 3**

Postoperative angiogram at eight years. Selective right coronary artery injection in the right anterior oblique position. **Top** Early phase. The dilated tortuous right coronary artery (RCA) has not changed compared to preoperative and early postoperative films. **Bottom** Late phase. The collateral vessels (arrows) are large and appear to be unchanged compared to those seen at seven weeks (fig. 2 right). The distal left circumflex (Cx) and first marginal branch (Marg) of the left circumflex artery are opacified by collateral vessels from the right coronary artery.

**Figure 4**

Postoperative angiogram at 8 years. Selective vein graft injection. **Top** Early phase. The vein graft (VG) is large, well opacified and without appreciable change from the early postoperative film (fig. 2 left). The anastomosis to the proximal portion of the left anterior descending artery (LAD) shows no evidence of stenosis or tenting and the septal branches (S) are present and well opacified. **Bottom** Late phase. This photograph shows a persistence of collateral vessels (arrow) between the distal left anterior descending artery (LAD) and the same first marginal branch (Marg) of the left circumflex artery seen in figure 2 right. In figure 2 right this vessel filled through collaterals from the distal right coronary artery.
up of bypass grafts reported by El-Said and colleagues in children with this condition show a high incidence of graft occlusion and stenosis presumably related to technical difficulties of bypass grafting in children. There is no long term follow-up available in adult patients. This report is an 8-year angiographic follow-up of a 36-year-old man who had a saphenous vein bypass graft to his anomalous left coronary artery. Selective postoperative arteriography at 7 weeks and at 8 years demonstrated a large patent graft with excellent flow. Large collaterals between the distal right and left circumflex coronary arteries which were present preoperatively appeared to be the same size postoperatively without evidence of regression.

We did not measure graft flow in this patient but others have shown excellent flow at the time of bypass surgery in patients with this anomaly. Thomas and colleagues have shown rather torrential intraoperative graft flow in two patients which was augmented by 20 to 25% when the right coronary artery was temporarily occluded. Follow-up at two months in one patient and seven months in the other demonstrated patent grafts and a smaller right coronary artery. In our patient there did not appear to be a significant postoperative change in the size of the right coronary artery. Reis and colleagues have also shown excellent intraoperative graft flow with normal variations in phasic flow during left ventricular contraction in a patient undergoing bypass surgery but there was no late angiographic study. Good graft flow usually means good distal run-off and is associated with a high late patency rate in patients with coronary artery disease. This patient had a patent graft at 8 years and this is one of the longest known graft follow-ups.

We have previously shown rapid regression of collaterals in almost all patients who have had an ischemic area of myocardium revascularized with a patent bypass graft. The failure of collaterals to regress in this patient may be the result of 1) a persistent gradient at the arteriolar level caused by inadvertent ligation of the proximal left circumflex artery, 2) continuing ischemia or 3) irreversible hypertrophy and enlargement of the collateral vessels. The phasic fluctuation in flow to the left circumflex artery, which at times is supplied by the distal right coronary artery and at times by the distal left anterior descending coronary artery, implies that a variable gradient is probably present at the arteriolar level. This is the most likely explanation of the persistent collaterals although myocardial ischemia and/or long standing irreversible hypertrophy and enlargement of these vessels may also play a role in their lack of regression.

Other late angiographic studies of adult patients with anomalous left coronary artery who have been treated with a bypass graft are needed. Studies of this type may elucidate the role of bypass surgery in influencing the natural history of adult patients with this condition.

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