Bypass Graft for Coronary Arterial Stenosis following Radiation Therapy*

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A 48-year-old man developed symptoms of progressive angina pectoris leading to myocardial infarction 12 years after two large doses of radiation for treatment of superior vena caval syndrome. Angiographic studies showed an isolated critical stenosis in the left anterior descending coronary artery, for which a successful surgical procedure for saphenous vein bypass graft was performed. Coronary arterial stenosis following radiation therapy has been reported rarely, but this case supports the thesis that such lesions can be treated surgically.

Radiation-induced damage to the heart, which may involve the pericardium, epicardium, myocardium, or the coronary arteries, has received comparatively little attention because the heart has been considered the most resistant organ when intrathoracic neoplastic disease is treated with high doses of radiotherapy. Stenosis of the coronary arteries is the least reported cardiac complication, but cases are on record which suggest that radiation can predispose these vessels to localized atheromatous change. A case recently reported from this institution has focused attention on this problem and prompted us to present the findings in a patient who developed severe stenosis of his left anterior descending coronary artery 14 years following two extensive courses of radiation therapy to the mediastinum. The onset of angina one year after the initial course of radiation therapy, with eventual progression to critical stenosis of the left anterior descending coronary artery, and the relative paucity of lesions in the other coronary arteries in this man could suggest that radiation-induced injury may have accelerated the development of atherosclerosis.

**CASE REPORT**

A 48-year-old Lebanese-American man was referred to one of us in October 1973 for evaluation of chest pain. In 1960 and 1963, respectively, he had had two courses of cobalt therapy for a superior mediastinal mass. One year after his first course of radiation therapy, the patient had developed effort-induced angina, and with therapy he became asymptomatic. On May 19, 1973, he was awakened at 4:00 AM with severe precordial pain and was subsequently hospitalized. Serial electrocardiograms and studies of the levels of cardiac enzymes were diagnostic of an acute anterior wall myocardial infarction; however, after the usual period of convalescence, the patient continued to have increasing angina, despite adequate therapy. He did smoke one pack of cigarettes per day until May 1973, when he reduced his usage to one-half pack of cigarettes per day.

His past history revealed that in 1960, at age 34, the patient was hospitalized with a three-week history of swelling of the right side of the face and neck and the right upper extremity and pain in the right arm. Fluoroscopic studies, x-ray films of the chest, and a barium swallow showed a 9.7 × 11-cm soft multilobular mass in the superior mediastinum, which displaced the esophagus posteriorly and the trachea to the right. The right hemidiaphragm was paralyzed. Biopsies of the right scalene lymph nodes and a right axillary lymph node were done. The clinical diagnosis was Hodgkin’s disease. Grossly, the specimens for biopsy were yellowish-gray and soft. The cut surface showed adipose tissue on the periphery and pinkish-gray smooth tissue in the center. The pathologist’s diagnosis was nonspecific chronic lymphadenitis. With the presumptive diagnosis of lymphoma (because of the obstructive superior vena caval symptoms), radiotherapy was given, with complete regression of the mass and associated symptoms. One year following the cobalt therapy, the patient experienced pain and a sensation of pressure on the anterior middle portion of the chest, which was associated with exercise and emotional stress. The angina-like pain responded to short-term symptomatic treatment and eventually disappeared. In 1963, three years after the initial therapy, the superior vena caval obstruction reappeared, and another course of radiotherapy was administered, with relief of the symptoms. The patient has remained free of superior vena caval symptoms ever since.

**Radiation Therapy**

The clinical impression was that the patient had lymphoma with classic superior vena caval obstruction. Tissue diagnosis suggested nonspecific chronic lymphadenitis. In 1960, radiation therapy was given five days a week over a period of 15 days. The anterior mediastinum received 2,200 rads, and the posterior mediastinum received 1,600 rads (total mediastinal dose of 3,800 rads). Another dose of 1,800 rads was administered to the right supraclavicular region. The mass completely disappeared, and the patient became free of symptoms. In 1963 the superior vena caval obstruction reappeared, and therefore the patient was irradiated again, receiving 3,400 rads to the anterior mediastinum and 3,400 rads to the posterior mediastinum, (total dose of 6,800 rads) five days a week over a period of 21 days. After the second course of radiation, the mediastinal mass and the superior vena caval symptoms have not recurred.

The family history of this patient was remarkable in that his mother had cardiac arrest at the age of 71 years and died. His 80-year-old father is alive and has “water around his heart.” The siblings of his parents had had heart attacks. One 50-year-old brother of the patient has angina.

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Physical Examination

The pulse rate was 100 beats per minute and regular. The blood pressure was 120/80 mm Hg, and no paradox was noted. The patient's weight was 67 kg (147 lb), and his height was 172.7 cm (5 ft 8 in). He was well developed and had gray hair. There was no xanthelasmas, but arcus senilis was present. The jugular venous and carotid pulsations were normal. There was no lymphadenopathy. The lungs were clear. The apical impulse was normal, and an S4 gallop rhythm was audible. The liver and spleen were not palpable. All peripheral pulses were normal.

The patient's blood group was O positive, and the results of a complete blood count were normal. The fasting level of cholesterol was 206 mg/100 ml, the triglyceride level was 163 mg/100 ml, and the serum was clear. The resting ECG was normal. The chest x-ray film was normal, except for an elevated right hemidiaphragm.

Because of crescendo angina, even after the patient's myocardial infarction in May 1973, a selective coronary angiographic study was performed on Nov 2, 1973. This study showed a 99 percent stenosis in the left anterior descending coronary artery (Fig 1A) and only a minor irregularity in the middle part of the right coronary artery (Fig 2A). The left circumflex artery was completely normal. Left ventriculographic studies demonstrated hypokinesis of the anterior wall and the apex.

At surgery on April 16, 1974, the substernal area was extensively involved in a dense fibrotic reaction. The left internal mammary artery was reduced to a fibrotic thread. The pericardium and epicardium appeared to be slightly thickened. There were only a few adhesions between the pericardium and epicardium. There was no pericardial effusion. The myocardium appeared normal. Microscopic examination of the right atrial appendage showed no evident lesions. The site of the lesion in the left anterior descending coronary artery was not inspected, but the distal coronary artery appeared externally free of atheroma. A surgical procedure for saphenous vein bypass graft from the aorta to the distal portion of the left anterior descending coronary

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**Figure 1.** A (upper), Preoperative left coronary arteriogram (right anterior oblique view). There is 99 percent obstruction of left anterior descending coronary artery distal to first septal. B (lower), Opacification of saphenous vein bypass graft to left anterior descending coronary artery (right anterior oblique view).

**Figure 2.** Right coronary arteriograms (left anterior oblique view). A (upper), Before surgery. B (lower), After surgery.
artery was performed. The distal artery measured 3 mm, and the completed graft had a mean flow of 115 ml/min (30-sec ischemic reflex of 196 ml/min). The patient's postoperative course was essentially uncomplicated.

The patient experienced complete relief of angina and underwent repeat selective coronary angiographic study on May 8, 1975, which showed a patent saphenous vein bypass graft to the left anterior descending coronary artery (Fig 1B) and showed that the minor irregularity seen previously in the right coronary artery had progressed to approximately 50 percent stenosis (Fig 2B). The previously noted hypokinetic area of the left ventricle was not seen on the new study. The right hemidiaphragm remained paralyzed.

Discussion

The evidence linking the atheromatous change with this patient's mediastinal irradiation is circumstantial, but certain features of the case, such as the high total dose of radiation, may support the notion that therapy with ionizing radiation played a role.

In a review of their experience with radiation-induced heart disease, Stewart and Fajardo concluded that cardiac injury was related to a high dose and to the volume of the heart irradiated. They also stressed that repeat irradiation increased the incidence of cardiac involvement. Their one patient who died of a myocardial infarction, a 15-year-old boy, received 4,000 rads. A 33-year-old man studied by McReynolds et al suffered sudden cardiac death eight years after radiation therapy to the mediastinum (5,000 rads), right axilla (3,000 rads), and left axilla (3,095 rads). The patient reported herein had radiation therapy on two occasions three years apart, with a total dose of mediastinal radiation of 8,400 rads. Not only was the dosage high, but the added risks of repeat irradiation and some coronary risk factors were present. Both the left anterior descending and the right coronary arteries lie on the anterior surface of the heart immediately adjacent to the observed injury. Also, at surgery, there was objective evidence for extensive radiation-induced injury around the heart. Thus, we believe that we are justified in considering that this injury may have predisposed areas of these vessels to atheromatous change, as suggested by Cohn et al.

Another aspect of our case that suggests a relationship between radiation and the ultimate stenosis is the early onset of angina. The patient's symptoms started within the first year after the initial series of treatments, at an age when angina is uncommon. Experimental work suggests that atherogenesis is accelerated by ionizing irradiation, producing early occlusive lesions of the coronary arteries. Apparently, radiation alone does not produce the atherosclerotic lesions, but it acts synergistically with dietary factors to accelerate the process. This case illustrates such a possibility and reminds us that chest pain in a patient who has had radiation therapy can indicate significant obstructive coronary arterial disease which may be amenable to bypass surgery with a saphenous vein graft, provided, of course, that the runoff of the diseased vessels is adequate. Internal mammary anastomosis may not be suitable because, as we saw in this patient, the left internal mammary artery was a fibrotic thread.

References


Thoracocentesis of Loculated Pleural Effusions Using Grey Scale Ultrasonic Guidance

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Six patients with either malignant pleural effusion or empyema, in whom multiple conventional attempts at thoracocentesis were unsuccessful, were evaluated by ultrasound. In each case, a subsequent thoracocentesis guided by ultrasound produced sufficient fluid to enable a diagnosis to be established. In no case was pneumothorax produced.

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