The diagnosis is usually suggested as an incidental finding on chest roentgenography. The remainder of the patients may have recurrent respiratory infections, hemoptysis, or pulmonary arterial hypertension with congestive heart failure.1,2

Attempts at surgical management of absent right pulmonary artery have produced variable results. Pneumonectomy may benefit patients with recurrent or life threatening hemoptysis.3 Patients with pulmonary arterial hypertension and congestive heart failure have remained a problem despite early recognition of a feasible surgical option.7

To our knowledge, only three previous attempts to restore continuity between the main and hilar pulmonary arteries have been reported. In 1965, Kiefer et al,8 reported placement of a saphenous vein graft between the main and left pulmonary arteries in an eight-year-old girl. Although she survived, the graft did not remain patent. In 1968, Green et al,9 reported the direct anastomosis between the left and the main pulmonary arteries in a 13-month-old boy with significant clinical improvement. Although both of these patients lacked the left pulmonary artery, no other significant anatomic defects were present, and they were quite comparable to patients with absent right pulmonary artery with pulmonary arterial hypertension. Only one other patient has undergone placement of a prosthetic conduit between the right and main pulmonary arteries. Shakibi et al,10 reported the case of a ten-month-old boy who was much improved immediately postoperatively but died of hemoptysis three months later. The authors recommended lung biopsy with reconstitution of flow from the main pulmonary artery only in those patients without "arterial venous malformations." Two years postoperatively, our patient is asymptomatic receiving no medications and has had dramatic improvement in her pulmonary artery pressure.

REFERENCES
3 Fraentzel O. Ein Fall von abnormer communication der aorta mit der arteria pulmonalis. Virchows Arch Path Anat 1868; 43:420

Radiation Effect on Implanted Pacemakers

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It was previously thought that diagnostic or therapeutic ionizing radiation did not have an adverse effect on the function of cardiac pacemakers. Recently, however, some authors have reported damaging effect of the therapeutic radiation on cardiac pulse generators. An analysis of a recently-extracted pacemaker documented the effect of the radiation on the pacemaker pulse generator.

Use of ionizing radiation for diagnostic or therapeutic purposes has been suspected of being capable of destroying a pacemaker pulse generator. Earlier studies, however, failed to prove this suspicion. A case of pulse generator damage which was exposed to therapeutic doses of radiation was recently encountered.

CASE REPORT

A 67-year-old black woman was admitted because of acute atrial fibrillation, flutter, and ventricular rate of 34 per minute. She had several episodes of near syncope, but did not become unconscious. On Sept 23, 1981, she had a permanent pacemaker implanted through transvenous approach. The pulse generator was placed in the right pectoralis area, approximately 6 to 7 cm from the right sternal border. She was discharged uneventfully. On May 3, 1982, she was readmitted with dysphagia. Barium swallow, and later, endoscopic studies revealed an invasive squamous cell carcinoma of the midthoracic esophagus, 25 cm from the alveolar ridge (Fig 1). In addition, she was found to have microinvasive squamous cell carcinoma of the soft palate and oropharynx. Radiation therapy was begun on May 27, 1982, for the carcinoma of the thoracic esophagus. Therapy was delivered via an arc field measuring 6 × 10 cm on 4 MEV linear accelerator. A total of 6,300 rads were delivered in 35 fractions. It was estimated that approximately 1,500 rads were delivered to the area of her pacemaker during the total course of her radiation therapy.

At the radiation center, an ECG was performed, apparently because of the patient's dizziness. She was then re-admitted to the hospital with the studies revealing a malfunctioning pacemaker. Although the pacemaker had been programmed at 833 ms (72.3/minute), at this time, it had an interval of 640 ms most of the time (93 per minute). The QRS was followed by pacemaker artifact. Attempt at external reprogramming failed, and the pulse generator had to be replaced. Use of a magnet at the time of the pacemaker change caused total inhibition of the pacemaker activity. The patient was discharged uneventfully with the proper pacemaker function.

Pacemaker Analysis

The pacemaker was analyzed in the manufacturer's laboratories. Their studies found that the pacemaker's large scale integrated circuit was damaged by ionizing radiation. This large scale integrated circuit controls all timing and logic functions of the pacemaker. This circuit is fabricated with CMOS technology. The pulse interval was 820 ms; it was originally programmed at 833 ms. The sensitivity to negative and positive R-waves was noted to be 10.24 mv (for this model, normal is 1.0 to 2.5 mv). Also, the pulse interval magnet rate

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was noted to be 560 ms. The magnet rate is set at 89.7 per minute or 660 ms.

**Discussion**

For years, after clinical use of cardiac pacemakers, it was thought that radiation for therapeutic purposes did not have any effect on the function of implanted cardiac pacemakers. In 1969, Hildner et al. subjected two separate units to direct irradiation from a cobalt-60 teletherapy source. A ventricular demand type pacemaker was given a total dose of 10,000 rads, and a P-wave synchronous pacemaker was given a total of 46,000 rads. Each pacemaker was irradiated separately at a dose rate of 300 rads per minute and checked for performance. At no time during the irradiation of either pacemaker was there any detectable change in the output-pulse characteristics. Since they did not see any ill effect from the radiation exposure to the pacemaker, they proceeded with irradiating a patient with presumptive carcinoma of the right upper lobe bronchus. The patient was given 3,500 rads over a period of three weeks. No changes in the patient's pacemaker function were noted during or immediately after therapy.

In 1972, Eipper and Laufenberg, concluded that radiation therapy presented no danger to patients with pacemakers. In 1975, Walz et al. reached the same conclusion. However, in 1978, Marbach et al. showed that the effect of radiation therapy on pacemaker function could be severe, as they advised against radiation with betatrons. Adamec et al., in their own study, observed only mild changes in the first series containing the demand pacemakers. However, the programmable pacemakers, in the second series, for the most part showed complete sudden failure after varying dosages of irradiation. These failures lasted from 1 to 24 hours. They concluded that direct radiation of a programmable pacemaker at therapeutic levels should be avoided.

Katzenberg et al. stated that newer multiple programmable units which employ complimentary metal oxide semiconductors (CMOS) for their integrated circuits may be more sensitive to ionizing radiation than bipolar semiconductors, the circuitry of older pacemakers. Reasoning for utilizing CMOS is that they consume less power and are highly reliable. They reported the first case of pacemaker malfunction due to exposure of the generator to radiation therapy. This malfunction occurred at cumulative dosages of 3,000 to 3,600 rads to treat breast carcinoma.

**Conclusion**

Studies show that there is no deleterious effect from diagnostic x-ray exposures on the pacemakers, but radiation for therapeutic purpose could cause permanent malfunction of the pulse generator containing CMOS device. The mode of failure cannot be predicted.

Precautions should be undertaken with the proper shielding, or possibly moving the pacemaker generators to a new location using lead extenders. If these precautions cannot be carried out, since the dose is cumulative, the pacemaker performance should be monitored throughout the course of radiation therapy.

REFERENCES


**Cytomegalovirus Infection with Idiopathic Pulmonary Fibrosis**

**Diagnosis Suggested by Bronchoalveolar Lavage**

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Bronchoalveolar lavage was used to provide important diagnostic information for a patient found to have idiopathic pulmonary fibrosis and concomitant cytomegalovirus infection. The use of this procedure may not only provide useful information regarding the underlying disease, but may also suggest alternative diagnostic possibilities.

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