Radiation Myelopathy

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Delayed radiation myelopathy is of concern to neurosurgeons and neurologists because its diagnosis involves exclusion of other processes capable of causing progressive spinal-cord dysfunction. When it is found, it is almost always in patients whose spinal cords were included in a field of irradiation directed toward a malignant tumor outside the cord. Its appearance, sometimes abrupt, usually suggests an epidural metastatic tumor. Diagnosis evolves in two stages: 1) exclusion of surgical and non-surgical conditions unrelated to irradiation, and 2) recognition of well-established criteria for radiation damage to the affected cord segment.

As radiation techniques are revised to deliver maximal allowable tumor doses, the frequency of radiation myelopathy will probably increase until this presently uncommon complication becomes numerically significant. In this paper we present three cases of permanent radiation myelopathy and review the literature relevant to the problem.

Case Reports

Case 1. This 50-year-old woman was admitted to the University Hospitals on January 2, 1968, with a 1-year history of pain in the right shoulder and arm. She also complained of numbness and tingling in her right forearm and hand, and of weakness in her right hand.

Examination. X-rays of the cervical spine revealed an osteolytic lesion in the right first rib at its junction with the vertebra. Physical examination revealed tenderness at T-1 posteriorly, normal sensation in the right arm, weakened right-hand grip, and atrophy of the right hypothenar eminence.

Operation. On January 4, the right rib lesion was biopsied through a posterior approach. Frozen section was interpreted as either chondroma or chondrosarcoma. Resection was not complete. Permanent sections revealed moderately well differentiated chondrosarcoma.

No metastases were detected elsewhere in the body.

Radiation therapy. Postoperatively, 5150 rads of cobalt-60 was delivered to the lesion over 59 days through 7 × 14-cm portals. The center of the field was just above the clavicles. It was estimated that the cord received at least 4600 rads (650 rads/week).

Course. The patient was readmitted on December 30, 1968, with urinary incontinence and radicular left chest pain. She had had dysphagia and left leg weakness for 2 months, and she had been unable to walk for 2 weeks. Physical examination revealed marked spastic paraparesis, greater on the left, and a sensory level at T-7 on the right. She was thought to have spinal-cord compression secondary to metastatic tumor, but the cerebrospinal fluid (CSF) was clear with normal manometrics, and a myelogram revealed no abnormalities. The CSF protein was 49 mg%.

The patient was discharged to a rehabilitation unit on January 16, 1969. She had shown no improvement during hospitalization.

Case 2. A routine chest film on August 2, 1966, had revealed a right upper-lobe mass in this 63-year-old woman. She had spent 6 months in a sanatorium 25 years previously because of suspected pulmonary tuberculosis. She had smoked one pack of cigarettes a day for 40 years.

Examination. On admission 2 months later, tomograms of the lung lesion were suggestive of a neoplasm; sputum cytology was positive for adenocarcinoma.

Operation. On October 26, a right pneumonectomy exposed a 5 × 5 mass in the right hilum intimately associated with the pulmonary artery, but without involvement of the peritracheal nodes. The lesion was grossly resected.
Radiation therapy. In December, 1966, irradiation therapy was begun with a 1 MeV machine: 5700 rads were delivered over 55 days through a 15-cm portal. Cord dose was estimated at about 5700 rads (710 rads/week).

Course. The patient noted sudden onset of weakness in both legs, slightly greater on the right, and decreased sensation in the left leg in August, 1967. Her neurological deficits had increased in severity when she was readmitted on January 27, 1969, for evaluation. Pertinent physical findings at that time were bilateral hyperreflexia (greater on the right), and a sensory level to all modalities at T5–T6 on the left. A myelogram revealed no abnormalities: the cord did not appear to be displaced, enlarged, or atrophied. The CSF was clear and manometrics were normal; CSF protein was 106 mg%.

At present, the patient has had no further progression of her deficit. The patient has good bowel and bladder control and can walk without help.

Case 3. Routine physical examination on April 1, 1966, revealed a mass in the right lower side of the neck in this 37-year-old woman.

Operations. Biopsy on April 19 proved the mass to be a lymph node partially replaced with mixed papillary-follicular carcinoma of the thyroid. Subtotal thyroidectomy was done after a work-up disclosed no other evidence of metastatic disease.

In June, 1966, a 1-cm superficial nodule palpated in the right upper side of the neck was removed and identified as thyroid papillary carcinoma. On August 2, a right radical neck dissection was done and three of the 14 nodes removed were invaded by tumor cells. Postoperatively, a node developed behind the right ear. It, too, was a lymph node replaced with tumor cells.

Radiation therapy. On February 1, 1967, the patient was given 30 mc of Iodine\textsuperscript{131} in an attempt to destroy any residual functional thyroid tissue. The entire neck was then treated with cobalt–60; field size was $15 \times 8$ cm. A tumor dose of 5200 rads was administered over 47 days while the entire medias- tinum was treated concurrently through anteroposterior $12 \times 6$-cm portals delivering a similar tumor dose. The cord was thought to receive about 5000 rads with a probable overlap at T1–T2 (750 rads/week).

In September, 1967, numbness began in the right leg and subsequently progressed to involve the left leg and lower trunk over the next 2 months. Physical examination in November, 1967, revealed a right Horner's syndrome, hypesthesia below T-8, and spastic paraparesis. A myelogram done elsewhere on November 1, 1967, revealed no abnormalities; the CSF was clear with normal manometrics and CSF protein was 13 mg%.

Thereafter the patient had progressive loss of function below T-6 and, when admitted to our service, had bladder and bowel incontinence and spastic paraplegia.

A high thoracic cordotomy (T1–T2) was done on January 15, 1969, to relieve severe shooting pain in the right thorax and in both legs. At the time of operation, the arachnoid was slightly thickened and the cord appeared to be only 50% to 60% of normal size. There was no evidence of metastasis.

Review of Literature

In 1941, Ahlbom\textsuperscript{1} first described spinal-cord damage following radiation therapy of neoplasms outside the cord. This was followed in 1945 by a detailed clinical and pathological report by Stevenson and Eckhardt.\textsuperscript{15} In 1948, Boden\textsuperscript{3} reviewed the English literature, described 10 cases, and recommended guidelines for establishing cord tolerance to irradiation. These recommendations were modified by Pallis, et al.,\textsuperscript{18} in 1961 and by Locksmith and Powers in 1968.\textsuperscript{10} The currently accepted dose and treatment schedules that include the spinal cord are largely based on these papers.

Clinical Features

Reagan, et al.,\textsuperscript{14} classified radiation myelopathy into four clinical types.

Type 1. This is a benign form commonly occurring within several months after completion of radiation and resolving completely within several months. This benign type has been reported as late as 1 year after irradia-