Spinal cord glioma after multiple fluoroscopies during artificial pneumothorax treatment of pulmonary tuberculosis

Case report

Paul Steinbok, B. Sc., M.B., F.R.C.S.(C)
Division of Neurosurgery, University of British Columbia and Vancouver General Hospital, Vancouver, British Columbia, Canada

A patient is reported who developed multiple basal-cell carcinomas of the skin, a breast carcinoma, an astrocytoma of the spinal cord, and a bronchial carcinoid tumor following multiple fluoroscopies during artificial pneumothorax treatment for pulmonary tuberculosis. A review of the literature revealed no previously documented cases of radiation-induced gliomas of the spinal cord.

Key Words • radiation-induced tumor • spinal cord tumor • glioma • bronchial carcinoid tumor • breast cancer • basal-cell carcinoma

Carcinogenesis is a recognized complication of radiation exposure, and in recent years the carcinogenic potential of high-dose radiation, as used in cancer radiotherapy, and low-dose radiation, as used in diagnostic procedures, has been intensively studied. Mackenzie and Myrden and Hilt reported an increased incidence of breast carcinoma in patients who had undergone multiple chest fluoroscopies during artificial pneumothorax treatment for tuberculosis.

We are reporting such a patient who, in addition to a carcinoma of the breast, also developed multiple basal-cell carcinomas of the skin, a bronchial carcinoid tumor, and an astrocytoma of the spinal cord in the field of radiation exposure. To our knowledge there have been no previous reports of radiation-induced spinal cord gliomas.

Case Report

This woman was born in 1924. She had 129 pneumothorax treatments for pulmonary tuberculosis between February, 1944, and January, 1947. Chest fluoroscopy was performed before each pneumothorax treatment and probably after the early treatments, so that it is estimated that she had over 150 chest fluoroscopies. The duration of each fluoroscopy and the actual radiation exposure cannot be accurately estimated in retrospect, since the fluoroscopy machines are no longer available. Pneumothoraces were induced bilaterally.

Between February, 1960, and June, 1967, she had eight basal-cell carcinomas removed from her back and one from her right shoulder. In 1972, another basal-cell carcinoma was removed from her right wrist and, in 1975, one was excised from the right cheek.

In July 1967, a radical mastectomy was performed for cancer of the right breast. On histopathology, lobular carcinoma was found extensively scattered throughout the breast tissue, and there were two foci of infiltrating duct carcinoma, one in the upper outer quadrant and the other in the upper inner quadrant of the breast. In May, 1968, a simple left mastectomy was carried out for prophylactic reasons, and the pathology showed one fibroadenoma and lobular hyperplasia.

In 1967, the patient developed weakness in her right foot, but this progressed little over the next 5 years. In
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1972, she began to have thoracic back pain, and on examination was noted to have a mild paraparesis, with the right side more involved than the left. A myelogram demonstrated an intramedullary mass at the T-10 level, and a thoracic laminectomy was performed. A cystic mass containing yellow fluid was encountered, but there was no solid tumor. The cyst was drained, and a Silastic tube was left in the cyst cavity with the other end in the spinal subarachnoid space above the lesion. No biopsy was done, and a pathological diagnosis was not made at this time.

In September, 1976, the patient was investigated again because of worsening of her lower limb function over a 1-year period. In addition to the paraparesis, she now had a sensory loss to pain and temperature sensation on the left side up to the T-6 level. A myelogram via a cisternal puncture showed widening of the lower cervical cord and upper thoracic cord, with a block at the T7-8 level. A repeat laminectomy revealed a mainly solid intramedullary tumor. A tiny biopsy was taken, which showed a cellular fibrillar tumor composed of atypical astrocytes without mitoses or necrosis (Fig. 1). This was interpreted as a low-grade astrocytoma. She was given a course of radiotherapy using cobalt-60 (60Co), with 5000 rads to the cervical and thoracic cord and 3000 rads to the posterior fossa and lumbar region. She was stable neurologically at a 27-month follow-up examination.

During her hospitalization in 1976, a chest film showed a 2-cm opacity in the right upper lobe, and this lesion was not present on radiographs taken 2 years previously. In October, 1976, a right upper lobectomy was performed, and a circumscribed nodule was found, originating from the bronchus. This consisted of trabeculae and rosettes of uniform cells with round nuclei and abundant argyrophilic, argentaffin-negative cytoplasm, indicative of a carcinoid tumor.

Discussion

In this patient, four different types of cancer occurred in the field of exposure to x-irradiation, and although circumstantial, the evidence strongly

Fig. 1. Photomicrograph of a spinal cord biopsy. Left: Increased cellularity with a fibrillar pattern is present. H & E, × 95. Right: Neoplastic, well differentiated astrocytes are seen in a fibrillar background. H & E, × 200.
suggests that the radiation was important in the genesis of these tumors.

An increased incidence of breast carcinoma has been documented in atom bomb survivors, in patients receiving radiotherapy for acute postpartum mastitis, acne or hirsutism, and in patients who have undergone multiple chest fluoroscopies. Myrden and Hiltz noted that the incidence of breast cancer was increased in those patients who had had more than 75 fluoroscopies during artificial pneumothorax treatment for pulmonary tuberculosis. In the patient reported here, over 150 chest fluoroscopic examinations were carried out, and, although the actual radiation dose cannot be computed retrospectively, it seems likely that she was in the group at risk for breast cancer as defined by Myrden and Hiltz. The influence of radiation in causing breast cancer in this patient is further suggested by the fact that her breast cancer was atypical, with foci of duct carcinoma and lobular carcinoma occurring at the same time.

The patient developed 11 separate basal-cell carcinomas of the skin, and nine of these were within the field of radiation exposure. Skin cancer is a well known complication of radiation exposure, and both basal-cell carcinomas and squamous carcinomas have been reported, with the latter type predominating. Multiple basal-cell carcinomas unrelated to radiation constitute part of the nevoid basal-cell carcinoma syndrome in which other tumors, such as ovarian and uterine fibromas, cutaneous squamous-cell carcinoma, fibrosarcoma, and medulloblastoma may occur. Our patient does not fit into this syndrome, having none of the other major manifestations, such as jaw cyst, dyskeratotic “pit” of palms and soles, or positive family history. Furthermore, breast carcinoma, bronchial tumors, and astrocytomas have not been described in association with the nevoid basal-cell carcinoma syndrome, and it is probable that the basal-cell carcinomas in this patient, like her other tumors, were induced by radiation.

Radiation has been implicated as a cause of cancer of the lung in patients surviving the atom bomb, in persons treated with x-irradiation for ankylosing spondylitis, and in uranium miners. In animals, both benign and malignant lung tumors have been induced by radiation. Neither in man nor in animals has a carcinoid tumor of the lung been produced by radiation, and in this respect the lung tumor in our patient is unique.

The final tumor to be discussed is the astrocytoma of the spinal cord, which is the first reported spinal-cord glioma induced by radiation. Most of the neoplasms that follow irradiation to the central nervous system have been of mesodermal origin, with sarcomas predominating. Radiation-induced gliomas are rare. Brecher, et al., reported a malignant glioma in the frontal lobe of a rat that was protected by parabiosis and given whole-body orthovoltage irradiation. Castanera, et al., noted one cerebral glioma in 107 rats given 680 rads of whole-body orthovoltage radiation and three gliomas in 114 rats given 230 or 320 rads of whole-body radiation with neutrons. Malignant gliomas have also been induced in the brains of rats by chronic low-dose radiation with intracerebral implants of 60Co radiation sources or americium-241. Kent and Pickering reported a parietal lobe glioblastoma following orthovoltage radiation to the head of a monkey (Macaca mulatta), Haymaker, et al., noted glioblastomas in the brain of three out of 10 adult monkeys (Macaca mulatta) that survived more than 3 years after total-body irradiation with the proton beam, and Kemper, et al., found three separate glioblastomas in the brain of one of four adult monkeys (Macaca mulatta) 24 months after 1500 rads of single-dose, whole-brain, megavoltage radiation.

In humans, an increased incidence of brain tumors has been reported in patients who had been irradiated for treatment of tinea capitis, but the histological nature of the tumors so produced was not discussed. In a 1969 United Nations report on the effects of radiation, only four brain tumors were documented in man following therapeutic irradiation. One “tumor of basal ganglion” of unspecified type followed radiation of infants for thymic enlargement, whereas the other three, comprising two astrocytomas and one malignant glioma, followed radiation therapy for tinea capitis in children. More recently, Sogg, et al., reported the occurrence of a malignant astrocytoma in the right temporal lobe 5 years after 6007 rads of megavoltage radiation had been delivered to the suprasellar region of a 9-year-old girl for treatment of a craniopharyngioma. Bachman and Ostrom documented the occurrence of a possible radiation-induced glioblastoma at the site of a previously resected ependymoma. This patient had a parieto-temporal ependymoma resected at age 13 months, and was treated thereafter with 3960 rads of whole-brain radiation over 6 weeks. Five years later she was found to have a mass in the same region, but histologically this was compatible with either glioblastoma or severe radiation-induced encephalopathy.

The glioma in the patient described here is unique: on the basis of indirect evidence, it is the only glioma induced by radiation of an adult human; it is the only glioma of the spinal cord induced by radiation; and it is the only glioma that has developed after diagnostic radiation exposure.

Conclusion

It was thought that the four different types of malignant tumor in this patient were induced by radiation. The evidence is as follows: 1) the amount of radiation exposure has been shown to be carcinogenic in previous studies; 2) the latent period of between 13 and 25 years from the end of radiation exposure to the
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occurrence of the different tumors is in keeping with the latent period in other radiation-induced tumors reported in humans; and 3) the tumors occurred within the field of radiation exposure with the exception of two out of 11 basal-cell carcinomas of the skin.

Two of the tumor types in this case, namely the bronchial carcinoid tumor and the spinal cord astrocytoma, have not previously been reported to follow radiation exposure.

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References

Address reprint requests to: Paul Steinbok, M.B., F.R.C.S.(C), Division of Neurosurgery, University of British Columbia, 700 West 10th Avenue, Vancouver, British Columbia, Canada V5Z 1L5.