Radiobiology and Radiotherapy

HERMAN D. SUIT

Section of Experimental Radiotherapy, The University of Texas, M. D. Anderson Hospital and Tumor Institute, Houston, Texas 77025

There were no panel discussions or section meetings devoted to Radiobiology as such. A single section meeting was entitled Experimental Radiotherapy. W. R. Inci, McCredie, and Kruuv (Canada) estimated pO2 of a long-term transplanted C3H mouse mammary carcinoma when the transplanted tumors were approximately 1 cm in diameter. They observed increases in pO2 (electrode current reading) when the mice respired 100% oxygen at one atmosphere of pressure; this was further increased when 5% CO2 plus 95% O2 and 10% CO2 and 90% oxygen were respired. Estimates of blood flow through the tumor were made by analyses of temperature gradients between tumor, rectum, and ambient gas. According to their method, blood flow increased by 20% when respiring 5% CO2 and 95% O2 and 50% when respiring 10% CO2 and 90% O2 instead of 100% O2. Both amyl nitrite and chlorpromazine caused a decrease in blood flow. J. Haot (Belgium) reported that the mitotic frequency of Ehrlich ascites cells irradiated in vitro and subsequently grown in vivo exhibit marked circadian rhythm. This was not affected by administration of cycloamine or cystamine. However, the former showed the expected radioprotective effect on cell survival.

S. Balmukhanov, Yefymov, and Kleinblock (U.S.S.R.), described extensive studies of Ehrlich ascites cells that received serial doses of radiation in vivo. The resultant cell line examined, clearly, was more rapidly proliferating and was thought to also be more “radioresistant.” L. Revesz (Sweden), in the discussion, stated that the results of Balmukhanov were consistent with his own experiments; their observation of increased resistance of cells surviving large doses of radiation occurred for radiation administered under severely hypoxic conditions. These experimental conditions were in contrast with those of F. Sinclair (U.S.A.), who observed increased sensitivity of cells surviving large doses of radiation administered under aerobic conditions. P. Rubin (U.S.A.) presented results of experiments designed to compare relative efficacy of “low” and “high” daily dose irradiation of tumor infiltrating the spinal column and causing neurologic damage due to pressure of tumor on nervous tissue. He employed the Murphy lymphoma transplanted to the Sprague-Dawley rat. The studies were modeled on the earlier investigation of daily dose in treatment of mediastinal tumor in the rat. Large daily doses (500 R 3 times a day, i.e., 1500 R total dose) were consistently effective in reversing the paralytic state while the “low” dose schedule of 100 R/day usually failed to ameliorate the neurologic symptoms despite resolution of tumor.

R. D. Hoye, Weiss, and Minton (U.S.A.), presented results of laser photon (ruby, 6943 Å; neodymium, 10,600 Å) irradiation of two animal tumor systems. Although only small tumors (<1 cm diameter) were irradiated, the laser was not effective in achieving tumor control. Combined with either cytoxan or local X-irradiation, however, effectiveness was sharply increased. Because of the high pressure of the laser beam pulses, e.g., =100 psi for 1000 joules administered over 2–3 milliseconds, tumor cells were found to be dispersed widely through tissue planes. At the moment, this would appear to be a severely limiting factor to its clinical application.

The most provocative presentation in radiotherapy was that by V. Shanta, Krishnan Nair, and Krishnamurthi (India). They presented results of a double blind, randomly designed trial of Synkavit as a radiosensitizer for external beam radiation therapy administered to squamous cell carcinomas of the buccal mucosa. Only patients with histologically diagnosed tumors which involved ≥ 1/4 of the cheek but without skin ulceration were accepted. Twenty-five to 30 minutes prior to each treatment, patients received intravenously either 25 ml of distilled water (controls) or 25 ml containing 100 mg Synkavit. All treatments were performed on a single cobalt-60 unit; radiation dose was 6500–7000 rads in six weeks using a simple parallel-opposed beam technic. Complete disappearance of the tumor at 8 weeks was achieved in 17 of 75 control patients and in 28 of 70 patients who received Synkavit. At 3 years, 12 of 66 controls and 23 of 65 Synkavit patients were free of tumors. Both differences were significant. (P < 0.02 and 0.04, respectively). The authors emphasized that Synkavit showed no value in the radiation therapy of carcinoma of the anterior 1/4 of the tongue.

I. S. Cade and McEwen (United Kingdom), and P. Kunkler, Wassif, Shah, and Hutchinson (United Kingdom), presented preliminary results of controlled clinical trials of patients respiring pure oxygen at 3 atmospheres of pressure absolute for 15 minutes prior to and then during local X-irradiation of tumors of bronchus and bladder and of head and neck lesions, respectively. Results were disappointing in that survival and local control were not improved in the Cade and McEwen study and only suggestively better in the Kunkler et al. study for the O2-30 psi-treated cases. K. Chary and Grotenhuis (U.S.A.), presented details of their technic of interstitial radiation therapy employing plastic microspheres impregnated with lanthanum140 (half-life = 40.3 hr) or other appropriate isotopes. The technic features afterloading, i.e., placement of all needles and then injection of a constant quantity of radioactive material per unit length of needle tract as needles are withdrawn. To date only a small number of patients have been treated but the results are considered as promising.

Matsumoto, Nakauchi, Y. Umegaki, S. Mikuriya, and Nakano (Japan) have employed single dose irradiation with 4-mev electrons to treat 1.5 cm or smaller tumors near the bladder base after surgical exposure of the tumor. After cystotomy, the gross lesion is removed surgically and the tumor site irradiated. Postoperatively, some patients were given 3000 rads in a course of fractionated irradiation. No complications and no recurrences have been observed during periods of up to 14 months.

J. R. Andrews (U.S.A.) reviewed current status of radiobiology of fast neutrons and potential application of such neutrons to clinical radiotherapy. He cited recent data showing that the OER or oxygen enhancement ratio was in the range of 1.6–1.8 for neutrons of widely varying mean Linear Energy Transfer (LET) down to and including the LET of 14-mev neutrons. Although generating clinically useful dose rates of 14-mev neutrons does not present great engineering problems, there remain serious difficulties in design of effective collimating devices and of targets which have useful life spans, but are sufficiently small as to be appropriate for clinical uses.
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