Dermatologic Radiotherapy: The Risk-Benefit Ratio

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Most therapeutic modalities are associated with risks. Recent research has stressed the importance of quantitative risk assessments which permit comparisons with other risk factors, such as background radiation, hazards of other modes of therapy, and various life-style risks. Although more data are available on the theoretical and clinical aspects of radiation side effects than about the risks of any other mode of therapy, there is a large gap between the opinions of experts and the view of the public.

Late Somatic Radiation Effects

Non Stochastic Effects. These are effects that vary with the dose of radiation and require a relatively high threshold dose.

Cataracts. The lens is the most radiosensitive part of the eye. When given in fractionated doses, more than 350 rad (3.5 Gy) are needed to produce cataracts. In dermatologic therapy, the maximum exposure to the lens is smaller than 50 rad (0.5 Gy) even when tumoricidal doses are used for treatment of eyelid cancers, provided that proper radiation protection is used [1].

Fertility. The sperm count may be depressed temporarily by an absorbed dose of 0.25 Gy (25 rad). The absorbed dose required to cause permanent sterility is larger by at least an order of magnitude. In contrast to the non-stochastic effects on the sperm count, the effects on the descendants of the irradiated individual are considered stochastic and not dependent on a threshold.

Chronic Radiodermatitis. The cumulative threshold dose for fractionated therapy resulting in chronic radiodermatitis is greater than 1000 rad (10 Gy) for superficial roentgen-ray therapy. This dose was established in the landmark study by Sulzberger et al. [2] at New York University and recently confirmed by Rowell [3] in England who found no clinical sequelae following cumulative doses of 1200 rad (12 Gy). No large-scale studies are available to establish the threshold dose for chronic radiodermatitis for grenz rays qualities; a cumulative dose of over 5000 rad (50 Gy) is mentioned by most clinical investigators.

Radiogenic Skin Cancer. The latest recommendations of the International Commission on Radiologic Protection mention an absorbed dose of 2000 rad (20 Gy) for...
occurrence of skin cancers (basal cell carcinomas and squamous cell carcinomas) when superficial roentgen-ray qualities are used in fractionated doses. Rowell [3] found five cases of skin cancer in 100 patients treated with 1500 to 3000 rad (15 to 30 Gy). Radiogenic skin cancers following grenz-ray therapy are very rare. Only nine anecdotal cases were reported in the world literature for patients who received grenz-ray doses exceeding 10,000 rad (100 Gy). A recent retrospective study of over 14,000 Swedish patients by Lindelof and Eklund [4] was based on a maximum cumulative dose of 10,000 rad (100 Gy) but failed to establish a clear-cut threshold dose for squamous cell cancer because of the presence of other risk factors. The incidence of reported squamous cell carcinomas was extremely low. (Data on the incidence of radiogenic basal cell carcinomas were unavailable.) The Swedish study confirms the relative safety of cumulative maximum grenz ray doses between 5000 and 10,000 rad.

In comparison with the occurrence of cutaneous malignancies following fractionated radiotherapy of benign dermatoses, the incidence of cutaneous neoplasms secondary to superficial radiotherapy of skin cancers with high tumor doses (up to 6000 rad [60 Gy]) is extremely low; this may be related to the relatively small field sizes used for cancer therapy and the cell-killing effect of high individual and total doses administered over a short period of time. No quantitative data are available in the literature, to our knowledge.

**Late Stochastic Effects.** The frequency of stochastic effects is related to the dose without evidence of a threshold. Even very small doses may cause late effects in some individuals when large populations are considered. Most somatic risks of radiation (i.e., leukemogenesis and carcinogenesis of internal organs) are stochastic. Since there is no unequivocal evidence of injury in man received from low-dose medical treatments (under 50-rad organ dose), risk estimates are usually based on the linear hypothesis [5]. Because dermatologic radiation is relatively nonpenetrating, only two types of carcinoma are of practical importance.

**Thyroid Cancer.** This potential risk has been stressed in numerous articles during the past decade. While there is no doubt that ionizing radiation can cause thyroid cancer (for example, following thymus irradiation in childhood), this risk can be reduced to a minimum by proper radiation protection measures. Our own extensive dose measurements have shown that with lead shields over the thyroid region the thyroid dose is below 1 rad (less than 0.01 Gy) when the total facial region is exposed to 1000 rad (10 Gy) at 0.75-mm aluminum half-value layer [6]. The risk of death associated with this dose can be calculated as 1:1 million; this equals a reduction of life expectancy by eight minutes. Similar 1:1 million every-day risks of death are associated with smoking 1.4 cigarettes, eating 100 charcoal-broiled steaks, spending three hours in a coal mine, traveling 300 miles by car or 1000 miles by jet.

**Breast Cancer.** Excessive exposure of the breast may induce carcinomas (as in patients radiated for mastitis or following frequent fluoroscopies for tuberculosis). In dermatology, the risks are minimal when proper radiation protection standards are used [1]. The calculated breast exposure (50 mrad [0.5 mGy]) for 1000 rad (10 Gy) skin dose to the facial area is lower than exposures during mammography (xeromammography, 100 to 200 mrad [1 to 2 mGy]).

**Genetic Effects**

Heritable effects are considered stochastic, and no safe threshold dose is assumed. In dermatologic therapy, the use of simple gonad shields can effectively reduce doses to the gonad [1]. Measurements by various investigators confirm the protective effect of