Proton Minibeam Radiation Therapy Reduces Side Effects in an In Vivo Mouse Ear Model.

Abstract:
Proton minibeam radiation therapy is a novel approach to minimize normal tissue damage in the entrance channel by spatial fractionation while keeping tumor control through a homogeneous tumor dose using beam widening with an increasing track length. In the present study, the dose distributions for homogeneous broad beam and minibeam irradiation sessions were simulated. Also, in an animal study, acute normal tissue side effects of proton minibeam irradiation were compared with homogeneous irradiation in a tumor-free mouse ear model to account for the complex effects on the immune system and vasculature in an in vivo normal tissue model. At the ion microprobe SNAKE, 20-MeV protons were administered to the central part (7.2 × 7.2 mm(2)) of the ear of BALB/c mice, using either a homogeneous field with a dose of 60 Gy or 16 minibeams with a nominal 6000 Gy (4 × 4 minibeams, size 0.18 × 0.18 mm(2), with a distance of 1.8 mm). The same average dose was used over the irradiated area. No ear swelling or other skin reactions were observed at any point after minibeam irradiation. In contrast, significant ear swelling (up to fourfold), erythema, and desquamation developed in homogeneously irradiated ears 3 to 4 weeks after irradiation. Hair loss and the disappearance of sebaceous...
glands were only detected in the homogeneously irradiated fields. These results show that proton minibeam radiation therapy results in reduced adverse effects compared with conventional homogeneous broad-beam irradiation and, therefore, might have the potential to decrease the incidence of side effects resulting from clinical proton and/or heavy ion therapy.