A Moving-Frame Method in HDR Brachytherapy

The primary requirement in using HDR brachytherapy for the post-surgical treatment of microscopic soft tissue sarcoma is to adequately encompass the planning target volume, defined as a fixed distance from the surgical bed, with a prescribed dose by adjusting source dwell times in catheters. However, cold spots may exist when using the geometrical optimizations in a commercial planning system (Plato, Nucletron International Corp., Netherlands). The moving frame method described here allows us to determine the lowest dose points and to verify the dose distributions in the treatment depth. The treatment depth is a super-plane in a moving-frame. The moving-frame is defined by the surgical bed or 3D-implant surface. Any low dose point in the depth, d, is easily determined by

$$\{X_{i,j} + X_{k,l} + X_{k,l+1}, Y_{i,j} + Y_{k,l} + Y_{k,l+1}, Z_{i,j} + Z_{k,l} + Z_{k,l+1}\}/3 + d\ \{N_x, N_y, N_z\}$$

where the subscripts i and k are the labels of catheters; the j, l and l+1 indicate the source dwell positions in the two catheters; $\{N_x, N_y, N_z\}$is the normal vector of the implanted surface at the point. Using the moving frame method, we have found cold spots of 80-percent or lower at the treatment depth for implants with unevenly spaced catheters and for implants with several catheters. By minimizing the dose variation in the treatment depth, we can eliminate the cold spots and provide an optimum spatial and temporal source distribution.