Performance optimization on the sensitivity and uniformity of the LiPCDA film

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Purpose: Lithium salts of pentacosa -10,12-diionic acid (LiPCDA) films which are the active layer material of the recently developed in vivo dosimeters, lens-type dosimeter and a flexible film dosimeter, are required to high sensitivity and uniformity to achieve optimal dosimeter performance. The purpose of this study is to improve the sensitivity and uniformity by changing the concentration of pentacosa-10, 12-diynoic acid (PCDA) and manufacturing procedures.

Materials and Methods: The LiPCDA was composed of the PCDA, tetraethylammonium hydroxide (TEAH), lithium acetate, and water. The LiPCDA was produced by adding Lithium acetate after manufacturing procedures of filtering a solution of the PCDA, TEAH, and water. The LiPCDA films were fabricated with three groups according to the concentration of composition and manufacturing procedures in the study. The first group increased the concentration of the PCDA by 0% (reference film), 25%, 35%, and 45%. The second group was produced with/ without a ball mill in order to reduce the PCDA to a uniform size. The 8-12 μm filter was used to manufacturing procedures in reference film and both groups. Finally, the third group was fabricated by using a filter with 3-5 μm, 8-12 μm and 20-25 μm, and none-filter. The filter was used to ensure the uniformity of the film by filtering PCDA of a specific size. The film samples were irradiated with doses from 0.2 to 3 Gy using 6 MV photon beams. After irradiation, the pixel values (PVs) and the standard deviation (SD) of films were acquired with Epson 10000XL flatbed scanner and optical densities were calculated to obtain a dose response curve and to compare the sensitivity of films. The sensitivity of each group and the uniformity of the third group was analyzed.

Results: The film added the PCDA by 35% has the highest sensitivity for all films, which increased by 62.1% in 1 Gy than reference film. The film with the ball mill had the sensitivity increase of 9.6% compared to film without the ball mill. In the third group, the sensitivity was increased with the filter's size. However the coefficient of variation (CV) calculated by the PVs and the SD were obtained with 0.012, 0.011, 0.017, and 0.020 for the 3-5 μm, 8-12 μm, and 20-25 μm and none-filter, respectively. Since the lower CV shows the better uniformity, 8-12 μm filter, which presented the lowest CV, was most adequate in consideration of the uniformity of the film.

Conclusions: This study was conducted by the concentration of PCDA, the filter size and with/without the ball mill. The filter size of 8-12 μm turned out to be most adequate and the sensitivity of LiPCDA film could be increased by adding 35% PCDA and using a ball mill.

Keywords: Radiochromic films, Dosimetry, Sensitivity, Uniformity