AbstractID: 1794 Title: Criteria for Evaluating Air Pockets in Balloon-based Breast Implants

This project was designed, for balloon-catheter based implants for breast irradiation (MammoSite), to set criteria determining whether displacement of target tissue due an air bubble trapped between the exterior of the balloon and breast tissue is acceptable. The goals of this project were to: 1.) Determine a formula to find the volume of the air bubble and to project the effect on displaced tissue at the edge of the treatment radius; and 2.) Calculate the dosage at the furthest distance of the displaced volume and compare it to the prescription dose one centimeter beyond the radius of the balloon (the defined target volume in the absence of an air bubble). The method used standard calculus volumes of revolution. The assumptions made are as follows: 1. Tissue is non-compressible, 2. The shape of the air bubble is parabolic, 3. The balloon is spherical, 4. Displaced volume expands radially, 5. Dosage is inversely proportional to the radius squared, 6. Fulfillment of the prescription requires that the volume displaced must not exceed 5% of the target volume (Criterion #1) and that the dose at the most distal point of the displaced volume must be at least 95% of the prescription dose (Criterion #2). The general formulas found based on the assumptions above were:
Criterion #1:

$\pi w^2(h-r-\sqrt{r^2-h^2}) \le \frac{\pi(3r^2+3r+1)}{15}$ where r = radius of balloon, h = height of air bubble, and w = width of air bubble;

Criterion #2:

$.95 = \left[\frac{r+1}{r+m+1}\right]^2$, where $m = \left[\frac{r}{r+1}\right]^2\left(h-r-(r^2-w^2)^{\left(\frac{1}{2}\right)}\right)+\left((r+1)^2-\frac{(r+1)^2w^2}{r^2}\right)^{\left(\frac{1}{2}\right)}$