Vaginal Cylinders in High Dose Rate Brachytherapy: Do Different Point Prescriptions Affect Results?

Rachele Grazziotin Reisner, Elizabeth Nakano de Souza, Álvaro Souto, Daniele Libório, Afranio Macedo, Tiago Bernardino da Silveira, Carlos Manoel Araujo, Célia Viégas.

Radiation Oncology Department, Instituto Nacional de Câncer- INCA- Rio de Janeiro, Brazil.

PURPOSE

Post- operative uterine cancer patients occasionally need brachytherapy to reduce the risk of disease recurrence in the vaginal cuff. Options for applicators and prescription dose methods are available, but it is necessary to assess the actual cuff and vaginal wall dose variation in compliance with the prescribed dose.

MATERIALS AND METHODS

The American Brachytherapy Society states that 3-5 cm cylinder length should be used to properly cover the vagina at risk. Prescription was made to either surface depth or 0.5 cm depth, reporting both surface and depth doses and placing optimization points on both lateral surfaces, along the curved portion of the cylinder dome and at the apex. GammaMedplus™ Segmented Cylinder Applicator Set (figure 1) has 2 cylinders tip types. One with a deep ogive, where the source can be activated next to the surface (figure 2) and one with a shallow ogive, where the source can't reach the tip (figure 3).

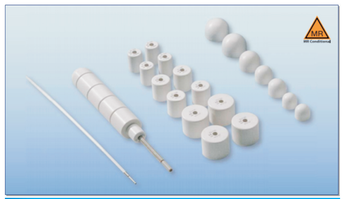

Figure 1: GammaMedplus TM Segmented Cylinder Applicator Set

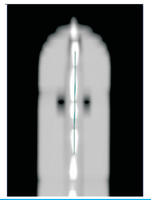

Figure 2: Deep ogive´s digitally reconstructed radiography.

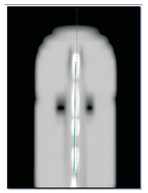

Figure3:Shallow ogive´s digitally reconstructed radiography

Prescription dose was determined on the cylinder tip and additional dose measurement points were created on the sides of this wall, cephalically, at the cylinder, tip, distally, to 4 cm of length of the cylinder, to 5 mm from the center line of the cylinder surface and at 5 mm from the tip of the cylinder. So that there were 5 doses simulation points, 5 to each dimension of cylinder (20, 25, 30, 35 mm), and for each type of depth, deep and shallow (figure 4).

For calculation, Brachyvision® 8.6 program and GammaMedplus™ were used. The data was tabulated in percentages related to the actual dose point prescription for each of the points (tip and 5 mm; lateral surface and 5mm, radially), evidencing how much each point reached in relation to the actual prescription surface (700 cGy) and 5 mm of depth doses.

Volumetric optimization was performed, considering the dome point and the lateral walls. The data was tabulated in an Excell® worksheet for analysis. The planning was considered acceptable when and if there is a variation on the surface dose points about 5%.

RESULTS

Eighty simulations were performed. The prescribed dose was 700 cGy. Summarized results are presented in table below.

Shallow Ogive Cylinder Doses Without Optimization Process

Cylinder	Dome	% Dose	0.5 cm lat	% Dose	Lateral wall Superior Limit	% Dose	Lateral wall Inferior Limit	% Dose	0.5 cm from Dome	% Dose
20 mm	354.3	51%	420.6	60%	667.4	95%	677.2	97%	185.80	27%
25 mm	389.3	56%	449.7	64%	671.2	96%	593.1	85%	216.60	31%
30 mm	366.6	52%	475.9	68%	655.4	94%	663.8	95%	225.50	32%
35 mm	348.2	50%	494.3	71%	666.0	95%	647.8	93%	231.90	33%

Shallow Ogive Cylinder Doses After Optimization Process

Cylinder	Dome	% Dose	0.5 cm lat	% Dose	Lateral wall Superior Limit	% Dose	Lateral wall Inferior Limit	% Dose	0.5 cm from Dome	% Dose
20 mm	661.0	94%	441.3	63%	1105.8	158%	669.7	96%	319.10	46%
25 mm	682.4	97%	478.6	68%	1050.8	150%	654.7	94%	357.00	51%
30 mm	677.4	97%	509.3	73%	1039.9	149%	668.8	95%	389.40	56%
35 mm	655.9	94%	605.5	87%	1269.8	181%	377.0	54%	425.20	61%

Deep Ogive Cylinder Doses Without Optimization Process

Cylinder	Dome	% Dose	0.5 cm lat	% Dose	Lateral wall Superior Limit	% Dose	Lateral wall Inferior Limit	% Dose	0.5 cm from Dome	% Dose
20 mm	428.8	61%	420.0	60%	671.0	96%	673.5	96%	205.70	29%
25 mm	671.5	96%	451.1	64%	670.0	96%	661.0	94%	305.40	44%
30 mm	920.0	132%	473.0	68%	637.3	91%	674.0	96%	400.4	57%
35 mm	1941.5	277%	497.4	71%	670.4	96%	670.1	96%	700.30	100%

Deep Cyllinder Doses After Optimization Process

Cylinder	Dome	% Dose	0.5 cm lat	% Dose	Lateral wall Superior Limit	% Dose	Lateral wall Inferior Limit	% Dose	0.5 cm from Dome	% Dose
20 mm	693.7	99%	431.3	62%	968.9	138%	671.1	96%	308.9	44%
25 mm	681.3	97%	452.2	65%	676.8	97%	661.2	94%	309.2	44%
30 mm	665.0	95%	473.4	68%	598.6	86%	672.1	96%	323.7	46%
35 mm	656.5	94%	488.9	70%	578.3	83%	669.0	96%	367.2	52%

The use of shallow cylinders led to a systematic underdosage on the dome and in the lateral walls (50- 56%). The deep ogives resulted in a 150-181% overdosage on the cephalic wall. Deep ogive without optimization generated under and overdosage on the dome (61-277%). Only 25 cm cylinders were able to achieve acceptable coverage in the distal wall (97%); the other dimensions presented overdosage (20 mm cylinders-130%) or under dosage in the distal wall (30 mm cylinders-86%, 35 mm cylinders -83%).

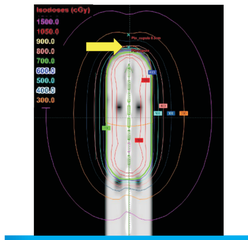

Figure 4:Without Dome Optimization: Dome Underdosage for all cylinders (50-56%).

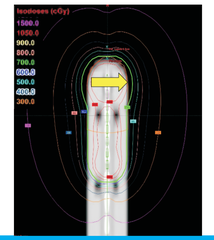

Figure 5: Dome Optimization: Dome Underdosage for 20 and 35 mm cylinders (94%); overdosage in cephalic wall for all cylinders (150-181%).

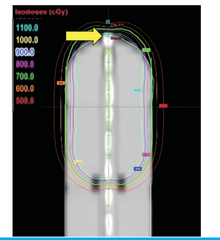

Figure 6: Without dome optimization: dome undersage for 20 mm cylinders (61%); dome overdosage for 30 and 35mm (132-277%).

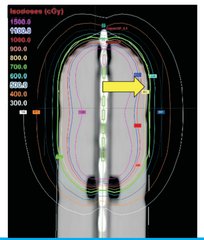

Figure 7: Dome Optimization: Underdosage in cephalic wall for 30 and 35mm cylinders (83-86%); overdosage in cephalic wall for 20mm cylinder (130%).

It was detected that only 25 mm cylinders provided adequate local tip and length isodose coverage; the remaining diameters provided inappropriate dosage.

CONCLUSION

Differences in brachytherapy dosage were found for vaginal canal cylinders and it was critical for 35 and 20 mm diameter cylinders. Only the 25mm diameter cylinder met both dose requirements at the dome and the lateral vaginal wall.

Alternative dose prescription methods or applicators have been found to minimize the risk of vaginal overdose or underdosage. Attention must be paid regarding dome and diameter selection, so as to avoid underdosage or overdosage affecting the therapeutic goal.

Projeto Gráfico: Serviço de Edição e Informação Técnico-Científica / INCA