Cervix Brachytherapy Dosimetry: Observed improvement in data submitted to clinical trials

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Purpose:

For over 40 years, the Radiological Physics Center (RPC) has reviewed the completeness, consistency with protocols, and the dosimetric accuracy of data submitted for cervix patients treated with brachytherapy on national clinical trials. In 2005 the RPC presented data which showed that 65% of cervix patients placed on study had one or more dosimetry errors in at least one of their implants. This study was conducted to determine if brachytherapy dosimetry has improved in the last 4 years.

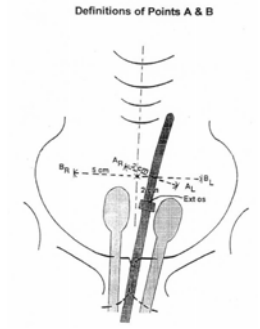
Methods and Materials:

In the last 4 years the RPC has reviewed 695 HDR and LDR implants, consisting of tandem and ovoid, tandem and ring and cylinder implants. Independent dose calculations were performed at points A, B, vaginal surface, bladder and rectum as defined by the protocols in accordance with ICRU-38[1]. The vaginal surface dose was defined as a point lateral to the center of the source (s) at 0.5cm from the surface of the cylinder or the dose at the surface of the ovoid. RPC doses were compared to the institution's reported doses. The RPC defines an error in dose to be ±15%.

ICRU – 38 Definitions

Point A – Defined as 2 cm along the intrauterine tandem in the superior direction from the flange, and 2 cm perpendicular to the tandem in the lateral direction.

Point B – Defined as 2 cm along the intrauterine tandem in the superior direction from the flange, and 5 cm lateral from the midline of the patient



Bladder Reference Point

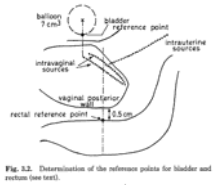
A Foley catheter is used. The balloon must be filled with 7 cm3 of radio-opaque fluid. The catheter is pulled downwards to bring the balloon against the urethra. On the lateral radiograph, the reference point is obtained on an anterior-posterior line drawn through the center of the balloon. The reference point is taken on this line at the posterior surface of the balloon. On the AP radiograph the reference point is taken at the center of the balloon.

Methods and Materials continued:

Rectal Reference Point

On the lateral radiograph, an anteroposterior line is drawn from the inferior end of the intrauterine sources (or from the middle of the intravaginal sources). The point is located on this line 5 mm behind the posterior vaginal wall. The posterior vaginal wall is visualized, depending upon the technique, by means of an intravaginal mould or by opacification of the vaginal cavity with a radio-opaque gauze used for the packing. On the AP radiograph, this reference point is at the inferior end of the intrauterine sources or at the middle of the intravaginal source(s).

Description of ICRU Bladder/Rectum Reference Points



Vaginal Surface Dose

The vaginal surface dose was defined as a point lateral to the center of the source (s) at 0.5cm from the surface of the cylinder or the dose at the surface of the ovoid.

Results:

The RPC has determined that from 2005 to 2009 dosimetry errors have decreased by 50%. Most remaining errors result from incorrectly defining calculation points. When the calculation points were defined correctly, the RPC agreed with the institutions' calculations in the majority of cases. However the use of CT has created some new issues due to the manipulation of the CT images when visualizing the tandem. The following shows the number of dose errors found for each point and the common reasons why those errors occurred.

Table 1: The results of implants that were reviewed by the RPC.

Point of Calculation	% Deviations (2005) (482 Implants Reviewed)	% Deviations (2005 – 2009) (695 Implants Reviewed)
A	6.6	3.7
B	32.9	18.3
Bladder	16.6	23.3
Rectum	37.4	54.0
Vaginal Surface	69.0	12.5

Results continued:

Common dosimetric errors for each point of calculation

Point A:

- Incorrectly determining the location of the external os.
- Using a distance other than 2 cm from the tandem to define the point.

Point B:

- Incorrectly determining the location of the external os.
- Using a distance other than 5 cm from the midline to define the point.
- Determining the point on a line perpendicular to the tandem rather than from the midline of the patient.
- Determining the point at the pelvic rim rather than at 5 cm from midline of the patient.

Bladder Point:

- Contrast was not used, therefore could not locate the bladder.
- On the AP view the point was not placed at the center of the bladder.
- On the lateral view the point was not placed on the midpoint of the bladder wall proximal to the implant.

Rectal point:

- Radio-opaque gauze, or other vaginal contrast, was not used.
- The institution's own rectal markers or contrast were used to determine the rectal point.
- A distance other than 5 mm from the vaginal wall was used to define the point.

Vaginal Surface:

- Defined at a distance rather than 0.5 cm from the surface of the cylinder or at the surface of the ovoid.

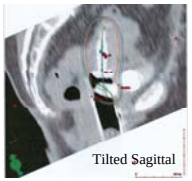
Common dosimetric errors made with CT image based planning

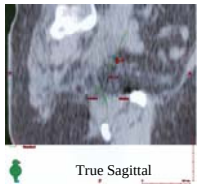
To view the sources the CT images need to be aligned by tilting the patient axis. Before defining the ICRU rectal and bladder points the tilt must be returned to a true coronal and sagittal view.

Results continued:

Rectum:

- Is determined on a true sagittal view. By leaving the image tilted the rectal point is located in an incorrect plane.





Bladder:

- The center of the bladder is determined on a true sagittal view. By leaving the image tilted the bladder point is located in an incorrect plane.

Conclusions:

The observed decrease in dosimetry errors is believed to be due to several different aspects: increase in rapid reviews (feedback given after 1st implant), more timely reviews (feedback given before additional patients placed on study) of patients and better communication with an institution when discrepancies are discovered. Points A, B, bladder, rectum and vaginal surface have been defined in clinical protocols, but a large number of institutions still do not use these definitions to calculate patient doses.

These reporting errors lead to inconsistencies in reported doses for the trial.

Participants in clinical trials should follow the protocols carefully to avoid making errors that can result in protocol deviations.

Credentialing of institutions to participate in clinical trials has been shown to reduce the frequency of calculation errors[2,3].

References

[1]Dose and Volume Specification for Reporting Intracavitary Therapy in Gynecology, ICRU Report 38, March 1985.

[2]Lowenstein,J.R, Roll, J., Hanson, H.W., Davis, D.S., Lanciano, R., Calkins, A., Petereit, D., Varia, M., Ibbott, G.S., Radiotherapy Quality Assurance of Gynecologic Oncology Group (GOG) Protocol 165, A cooperative Group Study of Carcinoma of the Cervix, Int J of Radiat Oncolo Biol Phys, Vol. 54, Issue 2, Suppllement 1, pg 283, 1 October 2002.

[3]Ibbott, G.S., Followill, D.S., Molineu, A., Lowenstein J.R., Alvarez, P.A., Roll, J.E., Challenges in Credentialing Institutions and Participants in Advanced Technology Multi-institutional Clinical Trials, Int. J. of Radiat Oncolo Biol Phys, Vol.71, Issue 1, Supplement 1, 1 May 2008, pg S71-S75.

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