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“Points” to “Profiles” in Brachytherapy for Cancer of the Cervix

Prof. N. R. Datta
Senior Consultant & Co-ordinator,
Department of Radiation Oncology,
Rajiv Gandhi Cancer Institute and Research Centre,
New Delhi, India
“Points” to “Profiles” in Brachytherapy of Cancer Cervix: Problems and Possibilities

Prof. N. R. Datta,
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(nrdatta@yahoo.com)
Possible approaches for dose prescription
Intracavitary brachytherapy: Cervix

- “mghr” in Radium era
- “Point A”: Todd & Merdith (1938 onwards)
- “ICRU reference volume” (ICRU 38, 1985 onwards)
- “Image based brachytherapy” (GEC-ESTRO guidelines, 2005 onwards)
Dose prescriptions based on “Point A”
“Point A”

An “Applicator dependent” point
“Point A” as Dose prescription point?

- Does it represent the point of crossing of the uterine artery and ureter?
- Does it represent the region of limiting radiosensitivity?
- Is it anatomically comparable amongst patients?
- Is it anatomically comparable within a patient, especially for multiple HDR brachytherapy?
CORRELATION OF TRADITIONAL POINT A WITH ANATOMIC LOCATION OF UTERINE ARTERY AND URETER IN CANCER OF THE UTERINE CERVIX

KUNG-LIAHNG WANG, M.D.,*† YUH-CHENG YANG, M.D.,*§¶ K. S. CLIFFORD CHAO, M.D.,‖
MENG-HAO WU, M.D.,† HUNG-CHI TAI, B.S.,† TZE-CHIEN CHEN, M.D.,* MING-CHAO HUANG, M.D.,*
JEN-RUEI CHEN, M.D.,* TSUNG-HSIEN SU, M.D.,*¶ AND YU-JEN CHEN, M.D., PH.D.†#

*Department of Obstetrics and Gynecology and †Radiation Oncology, Mackay Memorial Hospital, Taipei, Taiwan; ‡Department of Health Care Management, National Taipei College of Nursing, Taipei, Taiwan; §Department of Obstetrics and Gynecology, Taipei
Table 2. Distances between hypothetical and anatomic point A and brachytherapy specifications

<table>
<thead>
<tr>
<th>Patient</th>
<th>Axis of measurement</th>
<th>Lateral</th>
<th>Vertical</th>
<th>Anteroposterior</th>
<th>Shortest distance in a straight line</th>
<th>Tandem length</th>
<th>Ovoid distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Lateral</td>
<td>3.9 ± 0.3</td>
<td>4.6 ± 0.2</td>
<td>0.4 ± 1.0</td>
<td>0.2 ± 0.3</td>
<td>3.6 ± 0.3</td>
<td>3.0 ± 0.4</td>
</tr>
<tr>
<td>2</td>
<td>Vertical</td>
<td>5.8 ± 0.2</td>
<td>4.8 ± 0.3</td>
<td>0.1 ± 0.2</td>
<td>0.3 ± 0.3</td>
<td>3.1 ± 0.6</td>
<td>3.2 ± 0.5</td>
</tr>
<tr>
<td>3</td>
<td>Anteroposterior</td>
<td>4.1 ± 0.2</td>
<td>5.8 ± 0.3</td>
<td>0.7 ± 0.3</td>
<td>1.9 ± 0.6</td>
<td>2.2 ± 0.6</td>
<td>2.2 ± 1.1</td>
</tr>
<tr>
<td>4</td>
<td>Right</td>
<td>5.4 ± 0.3</td>
<td>4.5 ± 0.4</td>
<td>0.3 ± 0.1</td>
<td>0.2 ± 0.3</td>
<td>1.1 ± 0.2</td>
<td>1.3 ± 0.3</td>
</tr>
<tr>
<td>5</td>
<td>Left</td>
<td>2.9 ± 0.1</td>
<td>3.8 ± 0.2</td>
<td>1.9 ± 0.1</td>
<td>1.5 ± 0.2</td>
<td>2.5 ± 0.3</td>
<td>1.8 ± 0.3</td>
</tr>
<tr>
<td>6</td>
<td>4.9 ± 0.1</td>
<td>6.7 ± 0.2</td>
<td>3.3 ± 0.1</td>
<td>2.9 ± 0.2</td>
<td>0.4 ± 0.4</td>
<td>0.8 ± 0.4</td>
<td>6.0 ± 0.1</td>
</tr>
<tr>
<td>7</td>
<td>3.6 ± 0.2</td>
<td>3.6 ± 0.3</td>
<td>0.4 ± 0.3</td>
<td>0.1 ± 0.1</td>
<td>1.9 ± 0.4</td>
<td>3.2 ± 0.5</td>
<td>4.1 ± 0.1</td>
</tr>
<tr>
<td>8</td>
<td>3.4 ± 0.3</td>
<td>5.5 ± 0.3</td>
<td>0.2 ± 0.3</td>
<td>0.1 ± 0.5</td>
<td>2.8 ± 0.4</td>
<td>2.0 ± 0.7</td>
<td>4.4 ± 0.3</td>
</tr>
<tr>
<td>9</td>
<td>4.1 ± 0.7</td>
<td>3.8 ± 0.6</td>
<td>0.2 ± 0.7</td>
<td>0.1 ± 0.8</td>
<td>4.0 ± 0.6</td>
<td>2.8 ± 0.4</td>
<td>5.8 ± 0.5</td>
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<tr>
<td>10</td>
<td>3.7 ± 0.1</td>
<td>5.0 ± 0.2</td>
<td>0.2 ± 0.1</td>
<td>0.6 ± 0.3</td>
<td>0.9 ± 0.2</td>
<td>0.2 ± 0.6</td>
<td>3.8 ± 0.1</td>
</tr>
<tr>
<td>11</td>
<td>4.8 ± 0.6</td>
<td>4.3 ± 0.4</td>
<td>0.9 ± 0.2</td>
<td>0.4 ± 0.3</td>
<td>4.1 ± 0.3</td>
<td>3.1 ± 0.4</td>
<td>6.4 ± 0.5</td>
</tr>
<tr>
<td>Mean</td>
<td>4.2 ± 0.9</td>
<td>4.8 ± 0.9</td>
<td>0.1 ± 1.2</td>
<td>0.2 ± 1.2</td>
<td>2.4 ± 1.3</td>
<td>2.0 ± 1.4</td>
<td>5.2 ± 1.0</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± SD.

Mean ± SD (distances):
Difference between Hypothetical and Actual point A
Right side: 5.2 cm ± 1.0 cm
Left side: 5.4 ± 1.1 cm

Table 3. Estimated brachytherapy dose to the TPA and APA

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Dose to HPA (cGy)</th>
<th>Dose to APA (cGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>1</td>
<td>474.4 ± 6.3</td>
<td>473.9 ± 6.4</td>
</tr>
<tr>
<td>2</td>
<td>481.4 ± 4.8</td>
<td>479.2 ± 3.4</td>
</tr>
<tr>
<td>3</td>
<td>489.9 ± 12.8</td>
<td>479.7 ± 12.8</td>
</tr>
<tr>
<td>4</td>
<td>480.1 ± 2.6</td>
<td>477.9 ± 2.6</td>
</tr>
<tr>
<td>5</td>
<td>482.9 ± 4.8</td>
<td>480.3 ± 4.8</td>
</tr>
<tr>
<td>6</td>
<td>483.5 ± 4.2</td>
<td>481.3 ± 4.2</td>
</tr>
<tr>
<td>7</td>
<td>487.9 ± 12.9</td>
<td>485.9 ± 12.9</td>
</tr>
<tr>
<td>8</td>
<td>490.1 ± 10.5</td>
<td>488.7 ± 10.5</td>
</tr>
<tr>
<td>9</td>
<td>492.2 ± 3.5</td>
<td>490.9 ± 3.5</td>
</tr>
<tr>
<td>Mean</td>
<td>480.5 ± 7.5</td>
<td>482.2 ± 8.1</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± SD.

Abbreviations: TPA = traditional point A; APA = anatomic point A.


Dose to actual Point A ≈ 1/3rd Traditional point A
“Point A” with multiple intracavitary brachytherapy applications
Could there be a variation in
(a) Applicator geometry
and
(b) Its spatial position
during multiple HDR applications?

Its consequences on Reporting based
on "Points" and "ICRU Volumes"
Variations of intracavitary applicator geometry during multiple HDR brachytherapy insertions in carcinoma cervix and its influence on reporting as per ICRU report 38

Niloy Ranjan Datta\textsuperscript{a,*}, Shaleen Kumar\textsuperscript{a}, Koilpillai Joseph Maria Das\textsuperscript{a}, Chandra Mani Pandey\textsuperscript{b}, Shikha Halder\textsuperscript{a}, Sunder Ayyagari\textsuperscript{a}

\textit{(Radiother Oncol, 60, 15-24, 2001)}

- 20 patients; Total 80 applications
- Each had 4 HDR ICBT applications
- Dose: 6 Gy/fr. X 4 applications
- Applicator:
  - \textbf{Flexible Intrauterine polythene tube}
  - Hemispherical Aluminium ovoids
  - Ovoids attached to each other
  - Tandem free,
  - Conforms to uterine angulation both in AP and LAT directions
1\textsuperscript{st} application

Ralstron flexible applicator
2nd application
Ralstron flexible applicator
3rd application
Ralstron flexible applicator
4th application
Ralstron flexible applicator
Applicator & it’s co-ordinates
Across 20 patients : 4 applications each

<table>
<thead>
<tr>
<th>Applicator parameters</th>
<th>Co-ordinates (X, Y, Z)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ angle</td>
<td>$p = 0.001$</td>
</tr>
<tr>
<td>$\beta$ angle</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>IUTL</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>ROV</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>LOV</td>
<td>$p = 0.247$</td>
</tr>
<tr>
<td>ADL</td>
<td>$p = 0.041$</td>
</tr>
<tr>
<td>VDL</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>Os</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>IUTL</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>ROV</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>LOV</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>Point A (Rt)</td>
<td>$p &lt; 0.001$</td>
</tr>
<tr>
<td>Point A (Lt)</td>
<td>$p &lt; 0.001$</td>
</tr>
</tbody>
</table>

(Datta et al, Radiother Oncol, 60, 15-24, 2001)
Is there a variability during multiple HDR ICBT with rigid applicators?
Problems in reporting doses and volumes during multiple high-dose-rate intracavitary brachytherapy for carcinoma cervix as per ICRU Report 38: a comparative study using flexible and rigid applicators

Niloy R. Datta, M.D., D.N.B., a,* Rimpa Basu, M.D., a Koilpillai J.M. Das, Ph.D., a David Rajasekar, M.Sc., a Chandra M. Pandey, Ph.D., b and Sunder Ayvagari, M.D., a

(Gynecol Oncol 91, 285-292, 2003)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Ralstron</th>
<th>Rotterdam</th>
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<tr>
<td></td>
<td>p value</td>
<td>p value</td>
</tr>
<tr>
<td>α angle</td>
<td>&lt; 0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>β angle</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>IUTL</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>ROV</td>
<td>0.011</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>LOV</td>
<td>0.030</td>
<td>0.065</td>
</tr>
<tr>
<td>VDL</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>ADL</td>
<td>&lt; 0.001</td>
<td>0.012</td>
</tr>
</tbody>
</table>

- 25 patients with each applicator
- 3 HDR ICBT applications
- 150 applications evaluated
Rotterdam (fixed applicator)
Problems with Point A:
Uncertainty in doses with multiple HDR ICBT


Problems and uncertainties with multiple point A’s during multiple high-dose-rate intracavitary brachytherapy in carcinoma of the cervix.

Datta NR, Basu R, Das KJ, Rajasekar D, Pandey CM, Singh U, Ayyaqari S.

Department of Radiotherapy, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India.
nrdatta@sqpgi.ac.in
“Point A” as Dose prescription point?

- Does it represent the point of crossing of the uterine artery and ureter?
- Does it represent the region of limiting radiosensitivity?
- Is it anatomically comparable amongst patients?
- Is it anatomically comparable within a patient, especially for multiple HDR brachytherapy?
Impact on Tumor dose with respect to Point A

- FIGO stages II and III
- HDR - ICRT 2 weeks post EXTRT
- Insertions, n = 55
- CECT with CT / MRI compatible applicator
- 3 fr. at weekly intervals
Comparative assessment of doses to tumor, rectum, and bladder as evaluated by orthogonal radiographs vs. computer enhanced computed tomography-based intracavitary brachytherapy in cervical cancer

Niloy Ranjan Datta\textsuperscript{1,*}, Anurita Srivastava\textsuperscript{1}, Koilpillai Joseph Maria Das\textsuperscript{1}, Archana Gupta\textsuperscript{2}, Neeraj Rastogi\textsuperscript{1}

\textit{(Brachytherapy, 5, 223-9, 2006)}
Point A and the 6 Gy isodose
Relation to the tumour

Tumour encompassed within 6 Gy

Tumour outside 6 Gy isodose
% Tumour volume
Within 6 Gy isodose

Mean % tumour vol. covered by 6 Gy: 85%, p< 0.001

“Point A” dose may be inadequate for target coverage
Tumour volume coverage
Within point A dose

Tumour coverage related inversely with tumour volume
ICRU Bladder and Rectal Maximum doses

How well do these points represent normal organ maximum doses?
ICRU rectal maximum ($R_{\text{max}}$) dose point
ICRU bladder maximum ($B_{\text{max}}$) dose point
Difference between Bmax dose points

**Bmax: ICRU vs. CECT**

**Range**: -2.1 Gy to -10 Gy

**Mean difference**: -5.9 Gy, p<0.001

*Bmax (ICRU)* does not represent the actual *Bmax*
Difference between Rmax dose points

Rmax: ICRU vs. CECT

- **Range**: -8.8 Gy to +1.8 Gy
- **Mean difference**: -0.8 Gy, p=0.005

R_{max} (ICRU) does not represent the actual R_{max}
ICRU reference volumes as per ICRU Report 38
ICRU Report 38
Dose and Volume Specifications

1. Description of technique
2. Total reference air kerma (TRAK)
3. Description of reference volume
   • Dose level if not 60 Gy
   • Dimensions of volume – height, width, thickness
4. Absorbed doses at reference points
   • Bladder, Rectum, lymphatic spread, pelvic wall
5. Time dose pattern
When two or more intracavitary applications are performed, the absorbed dose to consider is that resulting from all applications.

- ICRU report 38
Reference volume dimensions

Multiple HDR ICBT applications
Fusion of 6 Gy isodose
From 4 HDR ICBT applications

Which ICRU 38 Reference Volume dimensions to report?
Should ICBT dose prescription be continued to be made at “Point A”? Any Evidence?
Point ‘A’ dose vs. central recurrence: No significant correlation

Bladder dose vs. Complication

Rectal dose vs. Complication

IJROBP 2000
Editorial

Dose and volume specification for reporting gynaecological brachytherapy: time for a change

Andries G. Vissera,∗, R. Paul Symondsb
<table>
<thead>
<tr>
<th>Parameter reported (HDR)</th>
<th>Questionnaire</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of the technique</td>
<td>100%</td>
<td>62 – 84%</td>
</tr>
<tr>
<td>TRAK</td>
<td>14%</td>
<td>0%</td>
</tr>
<tr>
<td>ICRU 38 Reference volume</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Dose specification : OAR / others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICRU Bladder point</td>
<td>58%</td>
<td>14%</td>
</tr>
<tr>
<td>ICRU Rectal point</td>
<td>55%</td>
<td>28%</td>
</tr>
<tr>
<td>ICRU Pelvic point</td>
<td>38%</td>
<td>4%</td>
</tr>
<tr>
<td>Lymphatic trapezoid</td>
<td>21%</td>
<td>0%</td>
</tr>
<tr>
<td>Time - dose patterns</td>
<td>0 – 100%</td>
<td>10 – 100%</td>
</tr>
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</table>
Survey of the use of the ICRU 38 in recording and reporting cervical cancer brachytherapy

Richard Pötter\textsuperscript{a,\#}, Erik Van Limbergen\textsuperscript{b}, Natascha Gerstner\textsuperscript{a}, André Wambersie\textsuperscript{c}

\textit{(Radiother Oncol, 58, 2001)}

<table>
<thead>
<tr>
<th>Parameter reported (HDR)</th>
<th>Questionnaire</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point A</td>
<td>89%</td>
<td>96%</td>
</tr>
<tr>
<td>Point B</td>
<td>65%</td>
<td>16%</td>
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</tbody>
</table>
THREE-DIMENSIONAL IMAGING IN GYNECOLOGIC BRACHYTHERAPY: A SURVEY OF THE AMERICAN BRACHYTHERAPY SOCIETY

AKILA N. VISWANATHAN, M.D., M.P.H.,* AND BETH A. ERICKSON, M.D.†

*Department of Radiation Oncology, Brigham and Women’s Hospital and Dana-Farber Cancer Institute, Harvard Medical School, Boston, MA; and †Department of Radiation Oncology, Medical College of Wisconsin, Milwaukee, WI

IJROBP, 76, 1, 104-9, 2010

Prescription Preference

Imaging modality for Target

Shift in Post-implant Imaging modality: CT
Dose prescription: Point A
Recommendations from Gynaecological (GYN) GEC-ESTRO Working Group\* (I): concepts and terms in 3D image based 3D treatment planning in cervix cancer brachytherapy with emphasis on MRI assessment of GTV and CTV

Christine Haie-Meder\textsuperscript{a,}\textsuperscript{*}, Richard Pötter\textsuperscript{b}, Erik Van Limbergen\textsuperscript{c}, Edith Briot\textsuperscript{a}, Marisol De Brabandere\textsuperscript{c}, Johannes Dimopoulos\textsuperscript{b}, Isabelle Dumas\textsuperscript{a}, Taran Paulsen Hellebust\textsuperscript{d}, Christian Kirisits\textsuperscript{b}, Stefan Lang\textsuperscript{b}, Sabine Muschitz\textsuperscript{b}, Juliana Nevinson\textsuperscript{e}, An Nulens\textsuperscript{c}, Peter Petrow\textsuperscript{f}, Natascha Wachter-Gerstner\textsuperscript{b}

\textbf{(Radiother Oncol. 74, 235 - 45, 2005)}

Recommendations from gynaecological (GYN) GEC ESTRO working group (II): Concepts and terms in 3D image-based treatment planning in cervix cancer brachytherapy—3D dose volume parameters and aspects of 3D image-based anatomy, radiation physics, radiobiology

Richard Pötter\textsuperscript{a,}\textsuperscript{*}, Christine Haie-Meder\textsuperscript{b}, Erik Van Limbergen\textsuperscript{c}, Isabelle Barillot\textsuperscript{d}, Marisol De Brabandere\textsuperscript{c}, Johannes Dimopoulos\textsuperscript{b}, Isabelle Dumas\textsuperscript{b}, Beth Erickson\textsuperscript{e}, Stefan Lang\textsuperscript{a}, An Nulens\textsuperscript{c}, Peter Petrow\textsuperscript{f}, Jason Rownd\textsuperscript{e}, Christian Kirisits\textsuperscript{a}

\textbf{(Radiother Oncol. 78, 67-77, 2006)}
# Recording and Reporting

## GEC-ESTRO guidelines

Still retains

- **Dose to point A** along with D100 and D90 for GTV, HR CTV and IR CTV

- **Doses to ICRU bladder and rectal points** along with D0.1cc, D1cc, D2cc, D5cc and D10cc for OARs

(Potter et al, Radiother Oncol. 78, 67-77, 2006)

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Recommendations for recording and reporting 3D gynaecological brachytherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete description of clinical situation including anatomy and pathology and imaging examination dimensions and volume of GTV at diagnosis and at time of brachytherapy dimensions and volumes of HR CTV and IR CTV, respectively Complete description of 3D sectional imaging technique and contouring procedure Complete description of brachytherapy technique radionuclide; source type (wire, stepping source); source strength; applicator type; type of afterloading (manual or remote); description of additional interstitial needles if any Treatment prescription and treatment planning applicator reconstruction technique, standard loading pattern, dose specification method; optimisation method, if applied Prescribed dose Total Reference Air Kerma (TRAK) Dose at point A (right, left, mean) D100, D90 for GTV and HR CTV and IR CTV, respectively Dose to bladder and rectum for ICRU reference points D0.1cc, D1cc, D2cc for organs at risk (e.g. rectum, sigmoid, bladder) (vagina^a^) D5cc, D10cc for organs at risk if contouring of organ walls is performed Complete description of time-dose pattern: physical and biologically weighted doses (<strong>a/β = 10 Gy</strong> for GTV and CTV; <strong>a/β = 3 Gy</strong> for OAR; <strong>T_{1/2} = 1.5 h</strong> for GTV, CTV and OAR)</td>
</tr>
</tbody>
</table>
Cancer cell density
3 defined target volumes

(Haie-Meder et al, Radiother Oncol. 74, 235 - 45, 2005)
MRI for GTV, HR CTV and OCR: “Brachytherapy Eye View”

Para-transverse  Para-coronal  Para-sagittal

Target Volume Delineation
(As per GEC-ESTRO guidelines)

GTV

HR CTV

IR CTV

Uncertainty in delineation ....?

(Haie-Meder et al, Radiother Oncol. 74, 235 - 45, 2005)
# Target volumes

As per GEC ESTRO guidelines

<table>
<thead>
<tr>
<th>Target Volumes</th>
<th>Delineated on</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTV(_D) (GTV at diagnosis)</td>
<td>T2 W image</td>
<td>Would be the IR CTV during brachytherapy</td>
</tr>
<tr>
<td>GTV(<em>B) (GTV at brachytherapy) (could be GTV(</em>{B_1,B_2,B_3}) for each subsequent ICBT application)</td>
<td>T2 W image</td>
<td>Would be the HR CTV during brachytherapy</td>
</tr>
<tr>
<td>High risk CTV for ICBT</td>
<td>Clinical examination, T2 W, take into account tumour at diagnosis</td>
<td>Includes whole cervix and extracervical tumor extension at ICBT</td>
</tr>
<tr>
<td>Intermediate risk CTV</td>
<td>Includes HR CTV with 5 – 15mm safety margin</td>
<td>To take into consideration the size, location, potential region of spread, tumour regression</td>
</tr>
</tbody>
</table>
SYSTEMATIC EVALUATION OF MRI FINDINGS IN DIFFERENT STAGES OF TREATMENT OF CERVICAL CANCER: POTENTIAL OF MRI ON DELINEATION OF TARGET, PATHOANATOMIC STRUCTURES, AND ORGANS AT RISK

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• **Attempted to delineate**
  – GTV at diagnosis (GTV_D)
  – GTV at brachytherapy (GTV_BT)
  – Cervical rim / corpus
  – OARs
  – Vaginal wall
  – Parametria

• **Scoring system from 0 to 3**
  (poor to excellent)

• MRI: 0.2 T with pelvic surface coil
• T1, T1C, T2 W
• 5 mm section with 1mm gap
• Marking gel in vagina
• Contrast in Foley’s balloon

IJROBP, 64,5, 1380-1388, 2006
(b): at brachytherapy

- Applicator
- GTV$_{BT}$ and grey zones
- Cervix ring
- Uterine corpus
- Bladder wall
- Rectal wall
- Sigmoid colon wall
- Vaginal wall
- Pelvic side wall
- Perirectal fascia

Parametria

Dimopolous et al, IJROBP, 64,5, 1380-1388, 2006
Can we paint the GREY AREAS to reduce the uncertainty?
PET – CT based brachytherapy in cervix
FDG-PET better than MRI for smaller tumours (< 14 cc)

PET-CT at
Rajiv Gandhi Cancer Institute and Research Centre, Delhi
At diagnosis
During 1\textsuperscript{st} ICBT with applicator (after 50 Gy Ext.RT)
During 1\textsuperscript{st} ICBT with applicator (after 50 Gy Ext.RT)
Spatial Geometry of Tumor vs. Coverage

Target volume = 17.8 cc
6 Gy coverage = 98.9%

Target volume = 25.5 cc
6 Gy coverage = 81.6%
Use of combined Intracavitary and Interstitial Brachytherapy in patients with gross parametrial involvement
MRI compatible Tandem-ring applicator with titanium needles (Vienna applicator)
Tandem-Ring with Needles (T-R + N) applicator
Dose distribution

Initial results with Vienna applicator

N=22 patients, IIIB and IIBB, 44 implants
Ext. RT: 45 Gy with HDR ICBT: 7 Gy x 4 fractions
Median follow up: 20 months (5 – 35 months)
2 year loco-regional control: 95% (21 / 22)
No Grade 3 or 4 acute or late toxicity

<table>
<thead>
<tr>
<th>Target / OARs</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose (HR – CTV) (Ext. RT + ICBT)</td>
<td>85 Gy</td>
</tr>
<tr>
<td>D100</td>
<td>70 Gy</td>
</tr>
<tr>
<td>D90</td>
<td>96 Gy</td>
</tr>
<tr>
<td>V100</td>
<td>93 Gy</td>
</tr>
<tr>
<td>ICRU bladder point</td>
<td>73 Gy</td>
</tr>
<tr>
<td>D2cc bladder</td>
<td>83 Gy</td>
</tr>
<tr>
<td>ICRU rectal point</td>
<td>71 Gy</td>
</tr>
<tr>
<td>D2cc rectum</td>
<td>66 Gy</td>
</tr>
</tbody>
</table>

Dimopoulous et al, IJROBP, 66,1, 83-90, 2006
Tandem ring with needle applicator
(Vienna applicator)
Image based Interstitial Implant with MUPIT
For greater parametrial and vaginal extension

MUPIT

Thumb rule:
(as estimated on Imaging and Clinical examination)

- Greater than medial $\frac{1}{3}$rd parametrial extension on either side

- Greater than $\frac{1}{3}$rd extension into vagina

- Greater than 3 cm cranial extension with lateral spread of > 1.5 cm from cervical os
So, what is do-able and desirable based on all the evidences?
“Points” to “Profiles”
Brachytherapy

From point A to the sculpted pear: MR image guidance significantly improves tumour dose and sparing of organs at risk in brachytherapy of cervical cancer

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\textbf{Conclusion:} Point A dose is a poor surrogate of HR-CTV dose, and the use of 3D image-based dose planning is encouraged. MRI-based IGABT significantly improves target coverage and OAR dose.
## Conclusions:

“Points” to “Profiles”- ICBT in Cancer Cervix

<table>
<thead>
<tr>
<th>Dose Prescription</th>
<th>Do-able</th>
<th>Desirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on “Point A”</td>
<td>Yes (++++)</td>
<td>In selected cases, With no parametrial / uterine extension</td>
</tr>
<tr>
<td>Based on ICRU 38 report and guidelines</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Image based brachytherapy</td>
<td>Yes (+++), Essential to form the learning curve using various imaging modalities, target volume definition needs clarity</td>
<td>Yes, in this era of Evidence based medicine as is for Ext. RT techniques - IMRT</td>
</tr>
</tbody>
</table>
An old wine in a new bottle
with
a new packaging and label
Acknowledgements....

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