AAMD 2018 Contouring Workshop  
Female Pelvis OARs  
Benjamin Nelms, PhD and Aaron Kusano, MD, SM  
June 17, 2018

The “Anatomy” of this Workshop ;)

1. Review Pre-Meeting Contouring Results  
   Prizes

2. Physician Lecture

3. Live Contouring Exercises & Instant Review of Results  
   Prizes

Move on to next structure
**Dice Coefficient:** Intuitive but Low-Sensitivity Measure of Accuracy

\[
\text{Dice Coefficient} = \frac{2 \times |X \cap Y|}{|X| + |Y|}
\]

For 3D anatomy, X and Y and the two volumes being compared.


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**StructSure Score:** High-Sensitivity Measure of Accuracy

- **Primary vs. Secondary Volume Comparison**
  - 1 mm Error: No Penalty (Forgiven)
  - 2 mm Error: Penalty = 0.5
  - 3 mm Error: Penalty = 1.0

Penalty per Error Voxel = (Voxel Penalty/mm) * (Distance Error mm – 1 mm Forgiveness)

Accuracy Score = 100 x [# Reference Voxels – S Voxel Penalties] / # Reference Voxels
A Contour Accuracy Metrics for Radiation Oncology

**Clinical Investigation**

**Variations in the Contouring of Organs at Risk: Test Case from a Patient with Oropharyngeal Cancer**

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There was significant inter-clinician variation in OAR contouring. The degree of variation is organ-dependent. We found substantial dose differences resulting strictly from contouring variation (differences ranging from −289% to 56% for mean OAR dose; −22% to 35% for maximum dose).

**Is a StructSure score predictive of DVH accuracy? Yes.**

Measuring Contour Accuracy is Important, but Disruptive

- In an ideal world,
  - we would have been measuring contouring accuracy starting in the 1990s when 3D planning became prevalent,
  - and even more so with the introduction of highly conformal plans (IMRT, VMAT, proton, etc.).
- This is not an ideal world.
  - However, better late than never.
  - The importance of high accuracy, high precision contouring is finally receiving its due ...
- But, what happens when we start measuring experienced, practicing professionals with a highly sensitive contouring metrics? Ooph!

Disclosures

- ProKnow Systems, LLC: paid consultant, clinical advisory board
- I don’t do heat and humidity
Outline

- Background
- Female Pelvis
- OARs
  - Small Bowel
  - Anorectum
  - Sigmoid
  - Uterocervix
  - Bladder

Background
“There’s only so many ways to make a 4 field box...”

Higher Doses, Better Conformality...but
“A review of target delineation and image segmentation prior to planning deserves more standardization.”

- Aggregate analysis of RO-ILS data indicates that more than a quarter of all reported events occurred in treatment planning
- Common Theme: events related to normal tissue definition
  - Critical structures not contoured
  - Normal tissues incorrectly or incompletely delineated
Hot off the presses for public comment....

Standardizing Normal Tissue Contouring for Radiation Therapy Treatment Planning: An ASTRO Consensus Paper

Jean L. Wright, MD, a Sue S. Yom, MD, PhD, MAS, b Musaddiq J. Awan, MD, c Samantha Dawes, CMD, d Benjamin Fischer-Valuck, MD, e Randi Kudner, MA, d Raymond Mailhot Vega, MD, MPH, f George Rodrigues, MD, PhD g

“Achieving plan optimization and maximal organ-sparing ultimately depends on the accuracy of OAR definition and delineation.”

Female Pelvis

FEMALE PELVIS
ORGANS AT RISK
Before we get into specific organs...let’s talk bowel bag

- Typically used in GU/GYN cases, always check with your team
- Still contour the rectum/anorectum
SMALL BOWEL

SMALL BOWEL EFFECTS

<table>
<thead>
<tr>
<th>ACUTE</th>
<th>CHRONIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>Adhesions</td>
</tr>
<tr>
<td>Malabsorption</td>
<td>Stricture</td>
</tr>
<tr>
<td>Nausea</td>
<td>Obstruction</td>
</tr>
<tr>
<td>Pain</td>
<td>+ Everything to the left</td>
</tr>
</tbody>
</table>
Acute Radiation Enteritis

Small Bowel Obstruction


SMALL BOWEL

- Mobile loops of bowel (3-6 meters!) connecting the stomach to the large bowel at the ileocecal valve in the RLQ
- Best delineated by administration of PO contrast at the time of simulation, at least 30 minutes prior to CT
- BUT...If you remember large bowel anatomy, contour colon and everything else will be small bowel
Contrast still making its way through

Anus and Rectum
### ANUS/RECTUM SIDE EFFECTS

<table>
<thead>
<tr>
<th>ACUTE</th>
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<tbody>
<tr>
<td>Diarrhea</td>
<td>Chronic Proctitis</td>
</tr>
<tr>
<td>Tenesmus</td>
<td>Ulceration</td>
</tr>
<tr>
<td>Mucus Discharge</td>
<td>Incontinence</td>
</tr>
<tr>
<td>Rectal Bleeding</td>
<td>Fistula</td>
</tr>
</tbody>
</table>


### RECTAL FISTULA

[Images of rectal fistula](www.bimjonline.com)
ANORECTUM

- Anus: 3-5cm, starts at anal verge best delineated by marker at SIM
- Rectum: 12-16cm, starts just after anus
- Why combine into Anorectum?
  - Including the anus is important when treating gynecologic malignancies as we are treating the distal vagina or vulva will contribute dose
  - Different acute and long term concerns in treating the anus and the rectum, but there is not specific dose constraints for the anus, it is grouped with the rectum to give the anorectum OAR

RECTUM

- RTOG: Inferior aspect starts at the lowest level of the ischial tuberosities
- Continue superiorly until just before rectum loses its round shape

ANUS

- Start at the anal verge, best identified by placing a marker at SIM
- Contour superiorly until reach the rectum which by RTOG definition will be at the lowest level of the ischial tuberosities.

- If contouring the anorectum, may avoid anal marker and just contour the anus and rectum in continuity going superiorly until transition to sigmoid
ANORECTUM

In this patient, using the lowest level of the ischial tuberosity as the landmark for the start of the rectum would have lead to an overestimate, but since we’re contouring anorectum, it doesn’t impact contour.

Scroll up and down and pay attention to the adjacent organs (vagina/cervix/prostate) to help define the wall of the rectum.

The shape of the rectum is going to vary widely, beware of just ending rectal contour when it is no longer a circle.

SIGMOID

Image Credit: agenciacutiva.com
SIGMOID STRicture

SIGMOID

- Mobile portion of large bowel connecting rectum to descending colon
- Sigmoid = “S-shaped”, averages 30-40cm in length, connects to the descending colon in the LLQ, will often curve sup-inf as well
- In females, lies in close proximity to and often drapes over the uterus and particularly important when brachytherapy is planned
Sigmoid contouring...lots of scrolling up and down

- Sigmoid contour starts where the AnoRectum contour ended
- Stops before connecting to the descending colon laterally
- Any sigmoid adjacent or above the uterus, as well as the brachytherapy applicator, should be contoured

Not all sigmoids read the same guidelines
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Not all sigmoids read the same guidelines
Instead of contouring the uterus and cervix as separate contours, RTOG consensus panel believed that it would be simpler and most reproducible to contour both as a single structure, given the difficulty in distinguishing them.

- Same argument applies to the ovaries and fallopian tubes
- Look for the transition from the typically flat but distentable vagina to the muscular, more circular cervix continuing superiorly not to include the fallopian tubes/ovaries (adnexa)
In order to best delineate the components of the female reproductive system, MRI is superior to CT
MRI can also be useful in distinguishing bowel in contact with the uterus that on CT would be very difficult to identify.
BLADDER SIDE EFFECTS

<table>
<thead>
<tr>
<th>ACUTE</th>
<th>CHRONIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>URGENCY</td>
<td>CHRONIC CYSTITIS (SEE LEFT)</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td>PAIN</td>
</tr>
<tr>
<td>DYSURIA</td>
<td>INCONTINENCE</td>
</tr>
<tr>
<td>HEMATOMA</td>
<td>STRicture</td>
</tr>
<tr>
<td>HEAMATURIA</td>
<td>FISTULA</td>
</tr>
</tbody>
</table>

BLADDER

- Generally pretty simple, contour inferiorly from its base and superiorly to the dome.
- Sometimes contrast in the bladder is helpful (for instance delineating adjacent vagina on CT) but it can also make it difficult if there is similar density small bowel contrast.
- Always look at your coronal and sagittal views to verify.
Thank you!

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