Target Volume Delineation in Carcinoma Anal Canal

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Learning Objectives

• Anatomy of Anal canal
• Lymphatic drainage and vascular supply
• Delineation of GTV and CTV
• Anatomical bony landmarks assisting delineation
Anatomy of Anal canal

- Anal canal extends from anorectal junction i.e. tip of coccyx (puborectalis/levator ani muscle forms a sling) to anal verge. Length = 3.8 - 4 cm
- Perianal skin = 5 cm radius around anal verge
Lymphatics of Anal Canal

3 pathways

- Anal canal sup to dentate line \(\rightarrow\) anal supra hemorrhoidal vessel (SHA) along sup. hemorrhoidal vessel (SHA) to perirectal, presacral nodes

- Anal canal sup to dentate line \(\rightarrow\) anal middle hemorrhoidal vessel (MHA) to Internal iliac nodes (pudendal, hypogastric)

- Anal canal inf. to dentate line (& Anal verge and anal margin) \(\rightarrow\) anal infra hemorrhoidal vessel to med. Supf. Inguinal nodes & External iliac (obt.)

Nodes at presentation:

- Pelvic LN = 30%
- Inguinal LN = 20-35%
AJCC Staging in Anal Caners

• T1: Tumor 2 cm or less in greatest dimension
• T2: Tumor >2 cm but less < 5 cm in greatest dimension
• T3: Tumor > 5 cm in greatest dimension
• T4: Tumor of any size invades adjacent organ(s), e.g., vagina, urethra, bladder (involvement of the sphincter muscle(s) alone is not classified as T4
• N1: Metastasis in perirectal lymph nodes(s)
• N2: Metastasis in unilateral internal iliac and/or unilateral inguinal lymph node(s)
• N3: Metastasis in perirectal and inguinal lymph nodes and/or bilateral internal iliac and/or bilateral inguinal lymph nodes

• Stage 0: Tis N0 M0
• Stage I: T1 N0 M0
• Stage II: T2 N0 M0 T3 N0 M0
• Stage IIIA: T1, T2, T3 N1 M0 T4 N0 M0
• Stage IIIB: T4 N1 M0 Any T N2, N3 M0
• Stage IV: Any T Any N M1
Sites of local recurrence

- Primary tumour bed
- Perineum
- Lymph nodal area
  - Mesorectum including the presacral space – includes perirectal and presacral nodes
  - Other lymph nodal area - internal iliac, external iliac and inguinal
Conventional Radiation Fields

Uninvolved inguinal nodes

• Phase I: AP & PA field, 36Gy/20#
  Sup- L5-S1 junction
  Inf- 2 cm below anal verge or growth
  Lat- most lateral part acetabulum

• Phase II: AP-PA field, 9Gy/5#, with sup margins lowered up to inferior level of SI joint

• Phase III: 15Gy/7# to area of gross disease with margin i.e. PTV by 3 fields (2 lat. & 1 post.) or 2 post ob. fields

If involved inguinal nodes
Why to Treat Inguinal nodes?

- In inguinal node positive disease: 5 yr survival rate 20% lower than node negative

Two situations:

1. Clinically Uninvolved inguinal nodes
   - If not prophylactically treated: Rate of failure is 20-25%
   - About half of nodal failures are uncontrollable
   - If prophylactically treated: Rate of failure is 5%
   - Elective lymphadnectomy is not recommended

2. Clinically Involved inguinal nodes
   - 80% control rate by CTRT or surgery+RT if nodes are not fixed
Pelvic lymph nodes: Anatomical Locations

- Maximum short axis diameter (MSAD)
  - 10 mm for common and ext. iliac LN & inguinal nodes
  - 8 mm for internal iliac nodes

- Common iliac - located lat. and post. to vessels
- External iliac - between med border of psoas/lat. border of pelvic cavity and vessel.
  - 3 groups-lateral, middle, and medial (obturator)
- Internal iliac - post. in pelvis, ant. to piriformis along middle rectal and internal pudendal artery
- Inguinal - in fat ant. and medial to femoral vessels

Sarah Swift, Target vol delineation ESTRO 2008 workshop
# CT defined lymph node levels

<table>
<thead>
<tr>
<th>Lymph node group</th>
<th>Recommended margins*</th>
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<tbody>
<tr>
<td>Common iliac</td>
<td>7 mm margin around vessels. Extend posterior and lateral borders to psoas and vertebral body</td>
</tr>
<tr>
<td>External iliac</td>
<td>7 mm margin around vessels. Extend anterior border by a further 10 mm anterolaterally along the iliopsoas muscle to include the lateral external iliac nodes</td>
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<tr>
<td>Internal iliac</td>
<td>7 mm margin around vessels. Extend lateral borders to pelvic side wall</td>
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<tr>
<td>Obturator</td>
<td>Join external and internal iliac regions with a 17 mm wide strip along the pelvic side wall</td>
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| Pre-sacral         | Subaortic: 10 mm strip over anterior sacrum  
Mesorectal: cover entire mesorectal space |

Radiotherapy Planning CT Simulation

- Prone/supine with full/semi-filled bladder
- Use immobilisation techniques (alpha cradle) ± bowel displacement maneuvers/ knee rest
- A radio-opaque marker placed at the anal verge or at the distal edge of palpable disease
- Oral and IV contrast
- Arms over chest or above head
- 5mm CT sections from L5 to 3-4 cm below anal verge
What is the target?

- GTV + CTVA – Primary tumour, enlarged LN, mesorectal fat (Perirectal tissue & presacral space)

- CTVN – B/L Internal Iliac LN, external iliac LN, inguinal

  **Upper pelvis** – ant wall of sacrum (Post.), sacral promontory (cephalad), presacral tissue up to iliopsoas laterally

  **Mid pelvis** – perirectal fat(Ant.), 1-2 cm of bladder/uterus

  **Lower pelvis** – perirectal fat and presacral tissue up to levator ani and inguinal nodes
CLINICAL INVESTIGATION

ELECTIVE CLINICAL TARGET VOLUMES FOR CONFORMAL THERAPY IN ANORECTAL CANCER: AN RADIATION THERAPY ONCOLOGY GROUP CONSENSUS PANEL CONTOURING ATLAS

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RTOG Anorectal Target Volumes Consensus Guidelines – 2008 (RTOG 0529 Protocol)

• For Anal canal: Primary Tumour
• GTV = All gross tumour + involved nodes (clinical & radiological)
• CTVA = 2 cm proximal and caudal to gross disease. It should include 2-2.5 cm normal perianal skin around the anal verge. It should include mesorectum, prescral and perianorectal tissue 2 cm cephalad and caudad to gross disease. 1 cm of posterior bladder/prostate/uterus/
• PTVA = 1 cm expansion from CTVA in all directions (trimmed to 3-5 mm to spare non target skin surface). CTVN(nodal) should not overlap with PTVA
• Dose to PTVA = 54-59.4Gy
Bladder - yellow line, GTV – Blue line, CTVA- Red line, PTVA- cyan line

Anal verge with 2 cm normal perianal skin
5 mm CT sections from sacral promontory to 2 cm below anal verge
5 mm CT sections from sacral promontory to 2 cm below anal verge
5 mm CT sections from sacral promontory to 2 cm below anal verge (cont.)

- Bladder: yellow line
- GTV: Blue line
- CTVA: Red line
- PTVA: cyan line
5 mm CT sections from sacral promontory to 2 cm below anal verge (cont.)

Bladder- yellow line
GTV – Blue line
CTVA- Red line
PTVA- cyan line
5 mm CT sections from sacral promontory to 2 cm below anal verge (cont.)

GTV – Blue line
CTVA- Red line
PTVA- cyan line
Sagittal Reconstruction
Showing tumour in anorectum
RTOG Anorectal Target Volumes
Consensus Guidelines for nodes- 2008

• For Anal canal : 3 elective nodal CTV
  For nodes 8mm- 1 cm expansion around vessels.(Ant.lat.=1cm)
  1. CTVa - Internal iliac, presacral & perirectal nodes
  2. CTVb - External iliac nodes
  3. CTVc - Inguinal nodes

• Elective nodal CTV dose = 45GY
CTVa (Internal iliac, presacral & perirectal nodal regions):
• Covers entire mesorectum sup. from sacral promontory to pelvic floor made by levator ani inferiorly. Anterior surface of sacrum posteriorly (presacral), iliopsoas /perirectal area laterally

**Mesorectum** -cylindrical, with cone-shaped tips in cranial and caudal direction
Starts at the level of the sacral promontory at the origin of the superior rectal artery and ending at the level where the levator ani muscle inserts into the rectal wall
RTOG Anorectal Target Volumes Consensus Guidelines- 2008

• CTVb (For external iliac nodal regions):
  • Cephalad- Upper end of SI joint (division of common iliac artery)
  • Caudad- Upper end of pubic rami (bottom of internal obturator artery)
RTOG Anorectal Target Volumes Consensus Guidelines- 2008

CTVc (For inguinal nodal regions):

- Cephalad: upper end of pubic ramus or at the inferior extent of internal obturator artery

- Caudad: 2 cm caudad to saphenous/l/femoral junction (SF junc. lies at 4 cm down & 4 cm lat. to pubic tubercle, LN is med. to vessel)
Upper Pelvis

CTVa
(Internal iliac, presacral, Perirectal)

CTVb
(external iliac)
Lower Pelvis

CTVa
(Internal iliac, presacral, Perirectal)

CTVc
(Inguinal)
Mid Pelvis

CTVa
(Internal iliac, presacral, Perirectal)

CTVb
(external iliac)

CTVc
(Inguinal)
Normal Tissue Contouring

No specific DVH recommendation for normal tissue by RTOG, still investigational but

- Femoral head, Iliac crest
- Small bowel up to 1 cm beyond PTVA
- Large bowel including rectosigmoid
- Bladder
- External genitalia
Dose Prescription

• After target volume delineation, IMRT dose prescription as follows:
• PTVA (Primary)= 54-59.4Gy
• CTVnodal= 45-50 Gy (45Gy: uninvolved, 50 Gy: < 3 cm, 54 Gy: > 3 cm)

Dose constrains to normal tissue:
Bladder 35 Gy < 50% vol
Large bowel 30 Gy <200cc vol
Small bowel 30 Gy <200cc vol
Femoral head 30 Gy < 50% vol
Iliac crest 30 Gy < 50% vol
External genitalia 20 Gy < 50% vol
Suggested Reading

- www.rtog.org (see Anal canal protocol RTOG 0529)