Contouring Guidelines for Prostate Cancers

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Three-dimensional treatment planning and conformal radiation therapy: preliminary evaluation


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Abstract

Preliminary clinical results are presented for 209 patients with cancer who had treatment planned on our three-dimensional radiation treatment planning (3-D RTP) system and were treated with external beam conformal radiation therapy. Average times (min) for CT volumetric simulation were: 74 without or 84 with contrast material; 36 for contouring of tumor/target volume and 44 for normal anatomy; 78 for treatment planning; 53 for plan evaluation/optimization; and 58 for verification simulation. Average time of daily treatment sessions with 3-D conformal therapy or standard techniques was comparable for brain, head and neck, thoracic, and hepatobiliary tumors (11.8–14 min and 11.5–12.1, respectively). For prostate cancer patients treated with 3-D conformal technique and Cerrobend blocks, mean treatment time was 19 min; with multileaf collimation it was 14 min and with bilateral arc rotation, 9.8 min. Acute toxicity was comparable to or lower than with standard techniques. Sophisticated 3-D RTP and conformal irradiation can be performed in a significant number of patients at a reasonable cost. Further efforts, including dose-escalation studies, are necessary to develop more versatile and efficient 3-D RTP systems and to enhance the cost benefit of this technology in treatment of patients with cancer.

Keywords: 3-D treatment planning; 3-D CT simulation; Radiation therapy planning; Conformal irradiation
Technical Innovation and Notes

VOLUMETRIC VISUALIZATION OF ANATOMY FOR TREATMENT PLANNING

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Dreblin 1988:
Volume rendering CT

Levoy 1988:
Surface volume data

- 3D CRT
- DVH
- TCP
- NTCP
PROSTATE

• Prostate cancer:
  - Localised Disease: Risk grouping
  - Locally Advance Disease (T3+ / N+)
  - Metastatic Disease

• Metastatic Disease: HT + RT + Bisphosphonates

• Locally Advance Disease: HT + RT (Prostate + Nodes)

• Localised Disease: Risk Grouping and Treatment
Surgery
bDFS 5 year: 80-95%,
10 Year: 75-85%
Incontinence: 10-15%
Impotence: 80-90%

Low risk disease:
(T1, T2a, Gleason 6, PSA ≤ 10)

NAAD + External Radiotherapy
bDFS 5 year: 80-90%, 10 Year: 70-80%
Incontinence: 2-5%,
Impotence: 40-60%
Bladder: 5% (III) 2-3% (IV)
Bowel: 10% (III) 3-5% (IV)

Bicalutamide 150 mg OD (total 3 weeks only)
Start LHRHa 3.6 mg sc 1 week after starting Bicalutamide.
Then monthly Injections (3.6mg x 6 & STOP)

Bicalutamide Monotherapy 150 mg OD for 6 months and STOP

Orchidectomy NOT recommended

Surveillance
Willing for close FU
Life expectancy <10 years
Non anxious
<50% of cores involved
Willing for curative Rx on progression

Radiotherapy Planning/Treatment
(6-8 weeks after NAAD starts)
3DCRT/ IMRT
Prostate alone

Instructions: 2 Tbsp Milk of Mag. HS before CT Simulator x 2 days
Void Urine then drink 500 ml Water starting 45 min before the Planning scan
Tattoo: Suprapubis + 2 laterals
CT Simulator : Supine, Hands on Chest, No Orfit, Knee rest
3mm slice thickness, from L4-5 to 3 cm below ischial tuberosity
CTV: Prostate + Base (Medial 0.5 cm, posteriorly) of SV
PTV: 0.8-1 cm all around
Dose 74Gy/37#/7.5 weeks
Portal Imaging/IGRT: Day 1, 2, 3, correct as required then weekly once
Intermediate risk disease (T2b, T3a, Gleason 7, PSA 11-20)
Lymph Node spread risk <30%
Roach Formula: 2/3PSA + (Gleason-6) x 10

Long term Hormones + External Radiotherapy
bDFS 5 year: 50-60%, 10 Year: 45-45%
Incontinence: 2-5%
Impotence: 46-69%
Bladder: 5% (III) 2-3% (IV)
Bowel: 10% (III) 3-5% (IV)

Start Androgen deprivation for 2-3 years

Bicalutamide 150 mg OD (total 3 weeks only)
Start LHRHa 10.8mg sc 1 week after starting Bicalutamide
3 monthly Injections (10.8 mg) for 2-3 years and STOP

Bicalutamide Monotherapy 150 mg OD for 2-3 years and STOP

Orchidectomy alone

Reassess at 3-6 months after starting Hormones (toxicity, PSA, DRE)
RT planning and Start RT

3DCRT/IMRT
Prostate alone
74Gy/37#/7.5weeks
Planning as described above

Continue Hormones after radiotherapy for a total duration of 2-3 years and STOP
**High Risk** disease: (T3b, Gleason 8-10, PSA >20)
Lymph Node spread risk >= 30%
Roach Formula: 2/3 PSA + (Gleason-6)x10

**Watchful Waiting**
- Frail
- Asymptomatic
- Life expectancy <5 years

**Long term** Hormones + External Radiotherapy
bDFS 5 year: 30-40%, 10 Year: 25-30%
Incontinence: 2-5%
Impotence: 40-60%
Bladder: 5% (III) 2-3% (IV)
Bowel: 10% (III) 3-5% (IV)

Start Androgen deprivation for 2-3 years

- Bicalutamide 150 mg OD (total 3 weeks only)
  Start LHRHa 10.8 mg sc 1 week after starting Bicalutamide
  3 monthly Injections (10.8 mg) for 2-3 years and STOP

- Bicalutamide Monotherapy 150 mg OD for 2-3 years

- Orchidectomy alone

Reassess at 3-6 months after starting Hormones (toxicity, PSA, DRE)
RT planning and Start RT

**3DCRT**
- Prostate alone
  74Gy/37#/7.5 weeks
  Planning as described above
  T3b: CTV= Prostate + entire SV (except tips of SV)

**IMRT**
- Prostate + Pelvic Nodes
  Prostate: 74Gy/37#/7.5 weeks
  Nodes: 55-60 Gy/37#/7.5 weeks
  Planning as described above

Continue Hormones after radiotherapy for a total duration of 2-3 years and STOP
Contouring in Prostate Cancers

- Volumes in defining prostate cancer
  1. Primary tumor & CTV
  2. Pelvic Lymph Nodes
- GTV contoured only if newer imaging like MR, MRS, etc done
- CTV depends on risk stratification
- PTV depends on immobilisation accuracy and machine parameters
CT v/s MR imaging: Differences

- Comparison of coronal views of the pelvis for prostate radiotherapy with (a) CT reconstructed from 2.5 mm slices and (b) MR image obtained in-plane in the same patient.
- Definition of the prostate gland boundaries and the adjacent structures is better visualized on MRI than with CT.
TARGET DELINEATION

No definite consensus guidelines

- $\text{GTV}_{\text{prostate}}$ : Gross tumor (delineated with newer Imaging)
- $\text{CTV}_{\text{prostate}}$ : GTV + Prostate only (low risk)
  - : GTV + Prostate + SV (Intermediate / High )
- $\text{CTV}_{\text{nodes}}$ : $\text{CTV}_{\text{vessels}}$ + 7 mm margin
- $\text{CTV}_{\text{pelvis}}$ : $\text{CTV}_{\text{prostate}}$ + $\text{CTV}_{\text{nodes}}$
- PTV : CTV + Margins

(Depending on Immobilization Accuracy)
Literature for Prostate Volumes

<table>
<thead>
<tr>
<th>Study</th>
<th>GTV</th>
<th>CTV</th>
<th>PTV</th>
<th>Prescription (TD/FS) in Gy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zelefsky et al&lt;sup&gt;11&lt;/sup&gt;</td>
<td></td>
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<tr>
<td>81-Gy plan</td>
<td>NS</td>
<td>P + SV</td>
<td>CTV + 1.0 cm UE (0.6 cm posterior)</td>
<td>PTV: 81/1.8 ≥ 90% to receive ≥ 70</td>
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<tr>
<td>86.4-Gy plan</td>
<td>NS</td>
<td>P + SV</td>
<td>CTV + 1.0 cm UE (0.6 cm posterior)</td>
<td>PTV: 86.4/1.8 ≥ 85% to receive ≥ 86.4</td>
</tr>
<tr>
<td>Ezzell et al&lt;sup&gt;18&lt;/sup&gt;</td>
<td>NS</td>
<td>P + SV</td>
<td>CTV + 1.0 cm UE</td>
<td>75.6/1.8 to ≥ 95% CTV</td>
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<tr>
<td>Jani et al&lt;sup&gt;12&lt;/sup&gt;</td>
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<tr>
<td>Phase I</td>
<td>P + SV</td>
<td>CTV1 = GTV1</td>
<td>PTV1 = CTV1 + 1.0 cm UE</td>
<td>PTV1: 50/2</td>
</tr>
<tr>
<td>Phase II</td>
<td>P</td>
<td>CTV2 = GTV2</td>
<td>PTV2 = CTV2 + 1.0 cm UE (0.6 cm posterior)</td>
<td>PTV2: 24/2</td>
</tr>
<tr>
<td>Sethi et al&lt;sup&gt;19&lt;/sup&gt;</td>
<td>NS</td>
<td>NS</td>
<td></td>
<td>PTV1: 55.8/1.8</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>PTV2: 18/1.8, 25.2/1.8, or 34.2/1.8*</td>
</tr>
<tr>
<td>Teh et al&lt;sup&gt;20&lt;/sup&gt;†</td>
<td>NS</td>
<td>Prostatic fossa and periprostatic tissues</td>
<td>CTV + 0.5 cm UE</td>
<td>PTV: 60-66/2 to 86% line</td>
</tr>
</tbody>
</table>

CTV = clinical tumor volume; FS = fraction size; GTV = gross tumor volume; NS = not specified; P = prostate; PTV = planned treatment volume; SV = seminal vesicles; TD = total dose; UE = uniform expansion

<sup>*</sup>Dose escalation (total dose, 73.8, 81, or 90 Gy)

† Subjects were studied postprostatectomy.
CTV_LOW RISK (Prostate ONLY)
PTV_LOW RISK

CTV +1cm (0.7 cm posterior)
CTV_INTERMEDIATE / HIGH RISK
SV Not involved: Base contoured
SV Involved: Whole SV Contoured
PTV_INTERMEDIATE / HIGH RISK

CTV +1 cm (0.7 cm posterior)
PROSTATE CANCERS AND NODAL DRAINAGE

- Periprostatic and obturator nodes
- Internal Iliac
- External Iliac
- Common Iliac
- Presacral
- Para-aortic

Contouring

- CTV VESSELS
- CTV Nodes : CTV Vessels + 7 mm margins
CTV Nodes: CTV Vessels + 7 mm

To exclude bones / lateral half of muscles

PTV : Margins according to Institutional Protocols (10 + 10 + 7 mm)
OAR

- Rectum
- Bladder
- B/L Femoral heads
- Small Bowel
Incorporation of newer imaging can define newer critical structures to reduce morbidity
SUMMARY

• Complete Evaluation, Staging and stratification at Diagnosis: Critical

• Appropriate treatment sequencing and counselling: Essential

• Radiological Anatomy: Mandatory for Radiation Oncologists

• Newer Imaging Modalities: Potential to reduce morbidity of RT

• Various Target volume definition and delineation: Learning Curve

• Consensus guidelines: Not yet established