Management of Soft Tissue Sarcoma

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Disclosure

Employer:
• Brigham and Women’s Hospital

Leadership Position:
• ASTRO Scientific Committee Sarcoma Track Vice-Chair

I have no financial conflicts of interest to disclose.
Learning Objectives

For extremity and retroperitoneal sarcoma, to understand:

- Patterns of spread
- Prognostic factors
- Optimal treatment approaches
- Risk factors for complications following RT
Overview

• Incidence and Epidemiology
• Diagnosis and Staging
• Prognostic Factors
• STS Extremity and Trunk
• Retroperitoneal Sarcoma
Soft Tissue Sarcoma Incidence

• < 12,000 cases in the US for 2015
• STS represents ~ 1% of all cancers
Pathogenesis

• Most have no clear etiology (>95%)

• Associated Genetic Syndromes
  – e.g. Li-Fraumeni, Familial Adenomatous Polyposis (FAP), NF 1

• Associated Environmental Factors
  – e.g. Radiation exposure, Lymphedema
Histopathologic Types

- ~25 major categories of STS
- ~60 types when subcategories are considered
  - >300 synonyms for these 60 types!

More Common Types:

- Pleomorphic sarcoma
- Liposarcoma
- Leiomyosarcoma
- Desmoid tumor
- Dermatofibrosarcoma protuberans
- Rhabdomyosarcoma
- Synovial sarcoma
- Malignant peripheral nerve sheath tumor
- Angiosarcoma
- Alveolar soft part sarcoma
- Ewing Sarcoma
- Extraskeletal osteosarcoma
- Myxofibrosarcoma
- Solitary fibrous tumor
- Epithelioid sarcoma
Difficulties with Pathology

- Rarity
- Diversity
- Change in diagnosis after specialist review: 30 - 70%*
- Disagreement among specialists: 25 - 40%**

**Coindre 1986, Hasegawa 2002
## Anatomic Sites of STS

<table>
<thead>
<tr>
<th>Anatomic Site</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Extremity</td>
<td>46%</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>15%</td>
</tr>
<tr>
<td>Superficial Trunk</td>
<td>15%</td>
</tr>
<tr>
<td>Retroperitoneal</td>
<td>15%</td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td>8%</td>
</tr>
</tbody>
</table>

Natural History

- Invade along muscle fibers, fascial planes
- LN involvement uncommon (5% overall)
  
  Exceptions “CARE” (15-20%)
  - Clear cell sarcoma
  - Cutaneous Angiosarcoma
  - Rhabdomyosarcoma
  - Epithelioid sarcoma

- Distant spread most commonly to lung, (bone mets are uncommon)
Patterns of Local Growth
- along paths of least resistance -
Diagnosis

Most STS present as asymptomatic soft tissue mass

Diagnostic Approach

• Core biopsy, Incisional biopsy
• Mass < 3 cm: excisional biopsy
• Orient incision parallel to long axis of underlying muscle
Staging Evaluation

• H + P

• Evaluation of primary
  – MR (extremity/ superficial trunk)
  – CT (retroperitoneum)

• Evaluation of distant disease
  – Chest CT
  – Bone or PET scan usually not necessary
TNM Staging System (2010)

T1 $\leq$ 5 cm
- T1a Superficial
- T1b Deep

T2 $> 5$ cm
- T2a Superficial
- T2b Deep

Grade is part of the staging system
## TNM Staging System (2010)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Grade (G)</th>
<th>T</th>
<th>N</th>
<th>M</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage IA</td>
<td>G1</td>
<td>T1a/b</td>
<td>N0</td>
<td>M0</td>
<td>Low grade, small</td>
</tr>
<tr>
<td>Stage IB</td>
<td>G1</td>
<td>T2a/b</td>
<td>N0</td>
<td>M0</td>
<td>Low grade, large</td>
</tr>
<tr>
<td>Stage IIA</td>
<td>G2,3</td>
<td>T1a/b</td>
<td>N0</td>
<td>M0</td>
<td>Moderate/high grade, small</td>
</tr>
<tr>
<td>Stage IIB</td>
<td>G2</td>
<td>T2a/b</td>
<td>N0</td>
<td>M0</td>
<td>Moderate grade, large</td>
</tr>
<tr>
<td>Stage III</td>
<td>G3</td>
<td>T2a/b</td>
<td>N0</td>
<td>M0</td>
<td>High grade, large or Node positive</td>
</tr>
<tr>
<td>Stage IV</td>
<td>Any GT</td>
<td>Any</td>
<td>N1</td>
<td>M0</td>
<td>Metastatic</td>
</tr>
</tbody>
</table>
Prognostic Factors for Survival

- Grade* (most important)
- Size
- Depth (Superficial/Deep to fascia)
- Site (Extremity vs Trunk/RP) (Distal vs Proximal)
- LN Involvement
- Age (young better than old)
Prognostic Factors for LR

- Marginal Resection
- Positive Margin
- Locally Recurrent disease
- Older age
- H & N and RP location
Treatment

• Management by Multimodality Team
  Radiology
  Pathology
  Surgery: Oncologic/Orgnopedic; Plastic
  Radiotherapy
  Medical Oncology
  Physical Therapy
  Social Work
Management at Experienced Center

• Associated with better outcome

Paszat, *Sarcoma* 2002
STS of Extremity and Trunk
Treatment for Low Grade STS

Generally surgery alone

Wide resection, Negative margins $\rightarrow$ LR <15%
Survival rate typically > 90%
Treatment for Low Grade STS

Generally surgery alone

- Wide resection, Negative margins $\rightarrow$ LR <15%
- Survival rate typically > 90%

Indications for RT

- Positive margins
- LR s/p prior surgery alone
- Tumor location not amenable to subsequent salvage surgery
Treatment for High Grade (G2/3) STS of Extremity and Trunk

Limb-Sparing Surgery (LSS) and RT
Treatment for High Grade (G2/3) STS of Extremity and Trunk

Limb-Sparing Surgery (LSS) and RT

Outcome

• Local Recurrence < 15%
• Survival varies by size, grade 2 vs 3
3 Classic Randomized Trials for LSS + RT for High Grade STS

Amputation vs LSS + RT
- NCI (Rosenberg Ann Surg 1982)
  - LR with LSS + RT: 15%; Equivalent OS

LSS alone vs LSS + RT
- NCI (Yang, JCO 1998)
  - Improved local control with RT; Equivalent OS
- MSKCC (Harrison, IJROBP 1993)
  - Improved local control with BRT; Equivalent OS
NCI Randomized Trial: Local Control

- Radiation
- No Radiation
MSKCC Randomized Trial: Local Control

Brachytherapy

No Brachytherapy

Tick mark (I) indicates last follow-up
- Brachytherapy (78 Pts. 65 Censored)
- No Brachytherapy (86 Pts. 61 Censored)

*p = 0.04
Treatment Technique
Principles of RT Planning

• Determine appropriate patient position

• Rigid immobilization (custom cast)
  – Critical to immobilize foot for LE, hand for UE

• Spare $\geq$ 1 cm strip of limb circumference ($<20$ Gy)

• Minimize dose to bone, joint, subcutaneous tissue
Immobilization
Immobilize Hand for UE

Immobilize Foot for LE
Treatment Volumes
GTV

• Use MR T1 post-gadolinium images
GTV

- Use MR T1 post-gadolinium images

CTV

- Expand GTV per guidelines
- Review MR T2 images to include peri-tumoral edema if feasible
RT Volume for Pre-op RT
Traditional Margins

CTV
- GTV + 4 cm proximal/distal, 1.5 cm radial
- Edit CTV at bone

PTV
- CTV + 5-10mm per institutional standard

*Haas, IJROBP 84:572; 2012
EXAMPLE:
Target Volumes,
Dose Distributions
7.2 x 6.1 x 7.2 cm

G3 leiomyosarcoma deep to L gluteal muscles

MR: Axial T1 post-gadolinium

Coronal T1 post-gadolinium
GTV, CTV, PTV
IMRT Isodose Distributions

- Conformal
- Spare
  - hip joint
  - subcutaneous tissue
IGRT to reduced target volume

- G2-3, tumor $\geq$ 8cm:
  - CTV sup/inf margins 3cm, radial 1.5 cm

- G2-3, tumor < 8cm
  - CTV sup/inf margins 2cm, radial 1 cm
IGRT to reduced target volume

• G2-3, tumor \( \geq 8\) cm:
  - CTV sup/inf margins 3cm, radial 1.5 cm

• G2-3, tumor < 8cm
  - CTV sup/inf margins 2cm, radial 1 cm

• 50 Gy pre-op RT
• Daily image guidance: kV, MV or CBCT
RT Volume for Pre-op RT: New Data

RTOG 0630

- 79 patients, 57 assessed for 2-yr late toxicity
- Median FU 3.6 yrs
- 84% Grade 2/3
- 75% IMRT, 25% 3D
RT Volume for Pre-op RT: New Data

RTOG 0630

- 79 patients, 57 assessed for 2-yr late toxicity
- Median FU 3.6 yrs
- 84% Grade 2/3
- 75% IMRT, 25% 3D

2 yr Local Control: 94% (all LF were within CTV)

≥ Grade 2 late toxicity: 10.5%
  Compared to 37% for NCIC pre-op arm (p<.001)
  Fibrosis 5.3%, Joint Stiffness 3.5%, Edema 5.3%
Conclusion:

“The significant reduction of late toxicities and absence of marginal-field recurrences suggest the target volumes used in RTOG-0630 are appropriate for pre-op IGRT for extremity STS”

This may be practice changing, confirmatory data are awaited
RT Volume for Post-op RT

First Course-
• Contour GTV and operative bed
• CTV = op bed + 1.5 cm radially, 4 cm longitudinally

Cone Down
• CTV = GTV + 1.5 cm radially and 2 cm longitudinally

CTV to PTV expansion = 5-10 mm per institutional standard

*Haas, IJROBP 84:572; 2012
RT Dose

Pre-operative RT (1.8 - 2 Gy)
- Pre-operative volume: 50 – 50.4 Gy

Post-operative RT (1.8 - 2 Gy)
- First Course: 45-50.4 Gy
- Cone Down: 16-20 Gy
- Total Dose: 60-66 Gy
Post-op Dose and Margins

Positive Margins (M+) $\rightarrow$ higher LR

DeLaney, (MGH) IJROBP, ’07

For patients with positive margins:

<table>
<thead>
<tr>
<th>Dose</th>
<th>5-yr Local Control</th>
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<tr>
<td>Dose &gt; 64 Gy</td>
<td>85%</td>
</tr>
<tr>
<td>Dose $\leq$ 64 Gy</td>
<td>66%   p&lt;.05</td>
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• We recommend 66-68 Gy
Post-op Dose and Margins

Positive Margins (M+) → higher LR

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• We recommend 66-68 Gy

Negative Margins

• I give 63 Gy
• 60-66 Gy is acceptable
Pre-op vs Post-op RT
<table>
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<tr>
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<th>PRE-OP RT</th>
<th>POST-OP RT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower Dose:</strong></td>
<td>50 Gy</td>
<td><strong>Higher Dose:</strong> 60-66 Gy</td>
</tr>
<tr>
<td><strong>Smaller Irradiated Volume:</strong></td>
<td>GTV + ~5 cm longitudinal margins</td>
<td><strong>Larger Irradiated Volume:</strong> operative bed + ~5 cm longitudinal margins</td>
</tr>
</tbody>
</table>
Pre-op vs Post-op RT: Efficacy

EQUIVALENT

• Several non-randomized trials have shown similar local control rates

• Canadian RCT\(^*\) 7 yr update showed:
  – Similar LC rates (92%, 93%)
  – Similar DFS and OS rates

\(^*\) O’Sullivan Lancet 110:817-22; 2014; JCO 22(14S):9007; 2004
Pre-op vs Post-op RT: Toxicities

DIFFERENT

PRE-OP

• More acute wound complications (35% vs 17%)
• Usually reversible

POST-OP

• More long-term edema, fibrosis, decreased ROM
• Usually irreversible
Pre-op vs Post-op RT

- Equivalent efficacy
- Different Toxicities
- Treatment approach should be individualized

- We prefer Pre-op RT for most situations
  - lower dose, smaller treatment volume → less irreversible long-term toxicity
RT Technique: 3D vs IMRT
IMRT

Goals:

• Maintain or improve local control rates achieved with 3D

• Reduce morbidities
  – Edema, joint stiffness, fibrosis, wound complications, fracture, etc
Comparison of Dose Distributions

Hong (MSKCC), IJROBP ‘04

Isodoses
Red: 100%
Light blue: 20-30%
Local Control Rates for Modern Series
3D Conventional and IMRT: Similarly Excellent

<table>
<thead>
<tr>
<th></th>
<th>5-yr LR</th>
<th>RT Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCIC RCT, 2004 O’Sullivan</td>
<td>6%, 7%</td>
<td>3D (100%)</td>
</tr>
<tr>
<td>BWH/DFCI, 2013 Baldini</td>
<td>10%</td>
<td>3D (84%)</td>
</tr>
<tr>
<td>MSKCC, 2014 Folkert</td>
<td>15.1%</td>
<td>3D (100%)</td>
</tr>
<tr>
<td>MGH, 2010 Kim</td>
<td>11.5%</td>
<td>3D (88%)</td>
</tr>
<tr>
<td>PMH, 2013 O’Sullivan</td>
<td>11.8%</td>
<td>IMRT (flap sparing, 100%)</td>
</tr>
<tr>
<td>MSKCC, 2014 Folkert</td>
<td>7.6%</td>
<td>IMRT (100%)</td>
</tr>
<tr>
<td>RTOG 0630, 2015 Wang</td>
<td>11.4%</td>
<td>IMRT (75%)</td>
</tr>
<tr>
<td>(2-yr)</td>
<td></td>
<td></td>
</tr>
</tbody>
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Comparison of Local Control: 3D vs IMRT
Folkert JCO 32(29):3236; 2014

• Non-randomized, 1996-2010

<table>
<thead>
<tr>
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<th>3D RT</th>
<th>IMRT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>154</td>
<td>165</td>
</tr>
<tr>
<td>Median FU</td>
<td>90 mos</td>
<td>42 mos</td>
</tr>
</tbody>
</table>
| 5-yr LR       | 15.1% | 7.6%  | p=0.05
Comparison of Local Control: 3D vs IMRT
Folkert JCO 32(29):3236; 2014

- Non-randomized, 1996-2010

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<td>42 mos</td>
</tr>
<tr>
<td>5-yr LR</td>
<td>15.1%</td>
<td>7.6%</td>
</tr>
</tbody>
</table>

- MVA: IMRT independent predictor for LC
  HR 0.46, p=0.02

*Patients who received IMRT had more unfavorable features: older, more high grade tumors, close/positive margins, and nerve manipulation
# Late Toxicity Results

<table>
<thead>
<tr>
<th>Institution</th>
<th>PMH*</th>
<th>MSKCC**</th>
<th>RTOG 0630***</th>
<th>Pre-op Arm NCIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Modality</td>
<td>100% IMRT (sparing flap)</td>
<td>100% IMRT (79% post-op)</td>
<td>75% IMRT</td>
<td>100% 3D</td>
</tr>
<tr>
<td>&gt; Grade 2: Subcutaneous Fibrosis</td>
<td>9.3%</td>
<td>NS</td>
<td>5.3%</td>
<td>31.5%</td>
</tr>
<tr>
<td>Joint Stiffness</td>
<td>5.6%</td>
<td>14.5%</td>
<td>3.5%</td>
<td>17.8%</td>
</tr>
<tr>
<td>Edema</td>
<td>11.1%</td>
<td>7.9%</td>
<td>5.3%</td>
<td>15.1%</td>
</tr>
</tbody>
</table>

• Use of IMRT may be the main reason for reduced toxicity

* O’Sullivan Cancer 2013, 119:1878;  
** Folkert JCO 2014, 32(29):3236  
*** Wang, JCO 2015, 33(20):2231
3D vs IMRT

• Local control is at least similar and may be better with IMRT

• Late toxicities appear to be lower with IMRT
Treatment Complications
Wound Complications: RCT
O’Sullivan, Lancet 2002

Major Wound Complications

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Pre-op RT</td>
<td>(31/88)</td>
<td>35%</td>
</tr>
<tr>
<td>Post-op RT</td>
<td>(16/94)</td>
<td>17%</td>
</tr>
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</table>

p=0.01
Wound Complications: RCT
O’Sullivan, Lancet 2002

Major Wound Complications

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Predictors for Wound Complication (MVA):

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op RT</td>
<td>3.08</td>
<td>.004</td>
</tr>
<tr>
<td>Size &gt; 10cm</td>
<td>1.11</td>
<td>.0005</td>
</tr>
<tr>
<td>LE vs UE</td>
<td>10.4</td>
<td>.03</td>
</tr>
</tbody>
</table>
Wound Complications
Baldini, Ann Surg Onc 2013

Major Wound Complications
Pre-op RT (36/103) 35%

Predictors for Wound Complication (MVA):

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Diabetes</td>
<td>5.6</td>
<td>.03</td>
</tr>
<tr>
<td>Size &gt; 10cm</td>
<td>6.2</td>
<td>.001</td>
</tr>
<tr>
<td>Tumor &lt; 3mm from skin</td>
<td>3.9</td>
<td>.03</td>
</tr>
<tr>
<td>Vascularized flap</td>
<td>6.4</td>
<td>.002</td>
</tr>
</tbody>
</table>
## Pre-op vs Post-op RCT: Late Effects

**AM Davis (Canada), Radiother Oncol 2005**

<table>
<thead>
<tr>
<th>&gt;= Grade 2</th>
<th>Post-op RT</th>
<th>Pre-op RT</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibrosis</td>
<td>48%</td>
<td>32%</td>
<td>0.07</td>
</tr>
<tr>
<td>Edema</td>
<td>23%</td>
<td>15%</td>
<td>NS</td>
</tr>
<tr>
<td>Joint</td>
<td>23%</td>
<td>18%</td>
<td>NS</td>
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<tr>
<td>Stiffness</td>
<td>23%</td>
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**Pre-op vs Post-op RCT: Late Effects**

AM Davis (Canada), *Radiother Oncol* 2005

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Larger field size correlated with:

- fibrosis (p<0.01), joint stiffness (p<0.01), & edema (p=0.06)
Bone Fracture
Lin (MSKCC), Cancer, 1998

• 205 pts w/ STS of thigh treated with S + RT
• 9 pts (0.04%) developed femur fracture

Risk factors for fracture:
• Periosteal stripping (5-yr fracture rate: 29%)
• Female gender
• Chemotherapy
Bone Fracture
Dickie (Canada), IJROBP, 2009

Matched pair analysis for 74 pts treated with CS + RT for LE STS

Lower risk of bone fracture if:

- $V_{40} < 64\%$
- Mean bone dose $< 37 \text{ Gy}$
- Max bone dose $< 59 \text{ Gy}$
Retroperitoneal Sarcoma (RPS)
RPS

Patterns Of Failure:
  – Predominantly LR: 50-80%
  – DR to liver and lung

Poor Outcome:
  – 5-yr OS ~ 50-60%
RPS

• Difficulties of Surgery
  – Proximity to critical organs, major neurovascular structures
  – “Radical (R0) resection” very difficult

• Difficulties of RT
  – Large tumor size
  – Normal tissue sensitivities
Retroperitoneal Liposarcoma
Favorable Prognostic Factors

• Complete resection (R0): negative margins
• Low grade
• Primary presentation (vs recurrent)
Surgery is mainstay and only curative treatment

Roles of RT and CT unproven

Unlike extremity STS, no randomized trials to guide treatment
  – One randomized trial (IORT)
Current Standard of Care: RPS

- Definitive resection—only proven treatment
- Many centers: no RT, pre-op RT
- Few centers: post-op RT, CT
RPS Management

Extrapolating from extremity data …

• Equivalent efficacy for:
  50 Gy pre-op RT (Tolerable for RP)
  60-66 Gy post-op (Too toxic for RP)

• If RT is given, most prefer pre-op RT
• Post-op RT is discouraged
Post-op RT for RPS is discouraged by Expert RT and Surgeon Panels*

• Too toxic
  – To give effective dose (60-66 Gy)
  – A lot of normal tissue falls into RT field

• If lower tolerable doses are given
  – Likely not effective
  – May render future surgery, RT more difficult

Since Many Centers Give Pre-op RT, How Should it be Delivered?

• There were no standard guidelines

• An expert panel was convened to develop guidelines

Treatment Guidelines for Preoperative Radiation Therapy for Retroperitoneal Sarcoma: Preliminary Consensus of an International Expert Panel

CTV Definition

Expand GTV symmetrically by 1.5 cm

Edit CTV:

• Bone, Retroperitoneal Compartment, Renal and Hepatic interfaces: 0 mm
• Bowel and Air Cavity: 5 mm
• Skin Surface: 3-5 mm
• If tumor extends through inguinal canal, add 3 cm distally (as per extremity STS)

If 4D CT is not performed, larger expansions are necessary for upper abdominal tumors
Dose

50 – 50.4 Gy

1.8 - 2 Gy fractions
RPS Contours

**A** Uniform 1.5 cm expansion (green)

**B** Edits along bowel, vertebral body, RP cavity (blue)

**C** Final CTV (blue)
Dose-Painting Boost to High Risk Margins

CONCEPT:
• Deliver boost dose of RT to areas of tumor at risk for positive margins after resection
• Along posterior abdominal wall, para-vertebral space, major vessels
Dose-Painting Boost to High Risk Margins

- Efficacy is unproven
- Technique is under investigation
- **Consensus recommendation:** best considered only on protocol or by experienced centers
OAR Constraint: Bowel

K Mak, PRO *in press*

- 56 pts treated with pre-op RT for RPS
- Delivered doses to bowel bag compared to constraints in literature (GI/GYN)
  - 75% exceeded constraint: $V_{15} > 830 \, cc$
  - 70% exceeded constraint: $V_{25} > 650 \, cc$
  - 75% exceeded constraint: $V_{45} > 195 \, cc$
OAR Constraint: Bowel

K Mak, PRO *in press*

- 56 pts treated with pre-op RT for RPS
- Delivered doses to bowel bag compared to constraints in literature (GI/GYN)
  - 75% exceeded constraint: $V_{15} > 830$ cc
  - 70% exceeded constraint: $V_{25} > 650$ cc
  - 75% exceeded constraint: $V_{45} > 195$ cc

- Acute GI toxicity: $\geq$ Grade 3: 5%

Above constraints are likely too conservative
Conclusions
Extremity/Trunk
RT Indications

Low Grade Sarcomas (G1)

- Locally recurrent
- Positive margins
- Locations not amenable to salvage surgery
RT Indications

Low Grade Sarcomas (G1)
- Locally recurrent
- Positive margins
- Locations not amenable to salvage surgery

High Grade Sarcomas (G2/3)
- All extremity or truncal lesions unless on protocol for treatment with surgery alone
RT Technique

• Careful, reproducible immobilization

• GTV $\rightarrow$ CTV expansion:
  – 4 cm longitudinal (now perhaps 3cm)
  – 1.5 cm radial

• Pre-op or Post-op RT acceptable
  – Associated with different morbidities
  – Wound complications vs fibrosis, edema
  – (Most prefer pre-op)
3D-CRT vs IMRT

• Both acceptable, IMRT preferred
  – Similar Efficacy (maybe IMRT is better)
  – Probably less toxicity with IMRT
Complications

Wound Complication Risk Factors
- Pre-op RT, lower extremity, large field size, tumor <3mm from skin, flap closure

Bone Fracture Risk Factors
- Periosteal stripping, chemo, high dose

Fibrosis, Edema, Joint Stiffness
- Large field size, high dose, post-op RT
Conclusions
Retroperitoneum
Standard of Care for RPS:
• Best attempt at R0 resection

Role of RT: unproven
• Best assessed on trial (EORTC)

If RT Given off Trial → Give Pre-op
• Follow expert consensus guidelines
• Boost to high risk margins best given on study
• Post-op RT is discouraged
Dana-Farber/Brigham & Women’s Cancer Center: Center for Sarcoma and Bone Oncology

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