SOFT TISSUE SARCOMA
(Non Rhabdomyosarcoma)
- **Soft Tissue structures**
  - Fat,
  - Muscles,
  - Fibrous tissue,
  - Blood vessels,
  - Supporting cells of peripheral nervous system

- **Soft Tissue Sarcomas:** embryologically arise Primitive mesenchyme of mesoderm, Some contribution from Neuro-ectoderm

- 0.6% of all malignancies

- **Age:**
  - Adults 15% in < 16 yrs
  - 40% in > 55 yrs

- **M : F = 1.12 : 1**
Anatomic Sites

- Arise any part of the body

  45% - Lower extremity
  17% - Trunk
  14% - Upper extremity
  12% - Retroperitonium
  10% - Head & Neck
Natural History

- **Pseudo-capsule**: inner rim normal tissue
  Outer rim - Oedema & reactive zone of small newly formed vessels

- **Low grade**: satellites of vital tumor found beyond pseudo-capsule excised by marginal excision.

- **High grade**: additional "skip lesions", outside the reactive zone near the pseudocapsule so wider excision.

- Tend to spread along longitudinal planes of muscular compartments. While fascial planes, nerves, vessels and bones are quite effective anatomical barriers.

- Though locally aggressive they rarely extend in adjacent tissue compartment until late
- **Hematogenous** dissemination most common to lungs account ≈ 50% of all initial recurrences
  then to Bone, Liver, skin < 5%
- **Lymphatic** dissemination uncommon (poor prognosis)
- 5.8% incidence of nodal spread during course of disease
- Histological sub-types:
  - 23% angio-sarcoma
  - 20% clear cell sarcoma
  - 20% epithelioid
  - 15% rhabdomyo-sarcoma
  - 14% synovial sarcoma
TNM staging system

T – Primary tumor

T1 - < 5cm in greatest dimension
   T1a - Superficial tumor
   T1b - Deep tumor

T2 – >5cm in greatest dimension
   T2a - Superficial tumor
   T2b - Deep tumor

N – Regional Lymph Nodes

   N0 - No regional lymph node metastasis
   N1 - Regional lymph node metastasis

M – Distant metastasis

   M0 - No distant metastasis
   M1 - Distant metastasis

G – Histopathologic grade

   Low grade
   High grade
Stage grouping

- **Stage IA** = LG, T1a/b, N0, M0
- **Stage IB** = LG, T2a/b, N0, M0
- **Stage IIA** = HG, T1a/b, N0, M0
- **Stage IIB** = HG, T2a, N0, M0
- **Stage III** = HG, T2b, N0, M0
- **Stage IVA** = any G, any T, N1, M0
- **Stage IVA** = any G, any T, any N, M1
Stage wise treatment options

- **Stage IA, IB**
  Surgery. External radiotherapy is added if margins are positive.

- **Stage II A, II B, III**
  Surgery ± Brachytherapy + Ext. radiotherapy.
  If margins are grossly positive, attempt re-excision (if feasible) to get negative margins, wherever possible.

- **Stage IV N1 Mo**
  Surgery ± Brachy + Ext. RT + Lymph Node Dissection

- **Stage IV No M1**
  Surgery ± Brachy + Ext. radiotherapy

  **metastectomy** of pulmonary metastasis.
  - No extrathoracic disease
  - Locoregional disease controlled or controllable
  - R0 metastectomy is possible
  - Good general condition
Standard Treatment

Wide local excision + PORT +/- Brachy
- Knowledge of anatomy essential
- Spread of disease along compartments
- Positioning
Mid-arm
MID-FOREARM

Flexor

Extensor
Mid-thigh
Mid-leg
Position

- Comfortable
- Reproducable

• Rotate the extremity to treat affected compartment while minimising dose to surrounding tissue
FROG-LEG position

Seperates ant. Thigh from post. & medial compartments
- Post compartment- Elevation leg on support stand
- Ant compartment- Leg resting on table
➢ ‘THROWING’ position

Shoulder 90 abduction & max ext rotation

Adequately separates Biceps compart. From Triceps
Postero-medial compartment
Immobilisation
Field placements

- keep uninvolved compartment out of radiation portal
- Avoid joints as far as possible
- Spare half circumference of uninvolved bone
- spare at least 1.5 - 2.0cm of limb circumference from radiotherapy portal.
- Margins not extend beyond natural barriers (Bone, fascial planes)
- Cover surgical scar & drain sites
Planning Target Volume (PTV):

Phase I - GTV+
  
  Grade I: 4cm margin
  Grade II&III: 6 - 8cm margin

Phase II - GTV+ 3cm margin
Seperation
Dose

Phase I - 50Gy / 25# / 5 weeks

Phase II - R 0:  10 - 12Gy / 5 - 6# / 1 week
               R 1:  12 - 16Gy / 6 - 8# / 1 week
               R 2:  16 - 20Gy / 8 - 10# / 2 weeks
During Treatment

- Skin care
- Physiotherapy
3D-CRT vs. IMRT FOR EXTREMITY SARCOMAS

IAEA Pediatric Radiation Oncology Training
Dr Laskar Version 1 June 2009
IAEA Pediatric Radiation Oncology Training
Dr Laskar Version 1 June 2009

Hong et al., IJROBP 2004
Table 1. Summary dose–volume histogram data showing averages, standard deviations, and p value for 10 patients (based on a 63 Gy prescription dose)

<table>
<thead>
<tr>
<th></th>
<th>IMRT</th>
<th>3D-CRT</th>
<th>Ratio (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(IMRT/3D-CRT)</td>
<td></td>
</tr>
<tr>
<td>PTV₁</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D95</td>
<td>97.0 ± 2.0%</td>
<td>97.0 ± 2.6%</td>
<td>100.0 ± 1.3%</td>
<td>0.85</td>
</tr>
<tr>
<td>V95</td>
<td>96.4 ± 1.7%</td>
<td>96.3 ± 2.1%</td>
<td>100.1 ± 1.1%</td>
<td>0.95</td>
</tr>
<tr>
<td>D05</td>
<td>109.8 ± 1.9%</td>
<td>110.4 ± 2.4%</td>
<td>99.4 ± 1.6%</td>
<td>0.28</td>
</tr>
<tr>
<td>Femur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V100</td>
<td>18.6 ± 9.2%</td>
<td>44.7 ± 16.8%</td>
<td>43.3 ± 17.8%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>D05</td>
<td>65.0 ± 1.2 Gy</td>
<td>67.2 ± 1.8 Gy</td>
<td>96.8 ± 2.7%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Dmean</td>
<td>38.5 ± 11.5 Gy</td>
<td>40.9 ± 12.7 Gy</td>
<td>94.9 ± 7.9%</td>
<td>0.06</td>
</tr>
<tr>
<td>Soft tissue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V100</td>
<td>200.8 ± 144.0 cc</td>
<td>996.7 ± 659.8 cc</td>
<td>22.1 ± 12.7%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>D05</td>
<td>58.7 ± 4.7 Gy</td>
<td>67.8 ± 1.3 Gy</td>
<td>86.5 ± 6.6%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Dmean</td>
<td>22.4 ± 4.8 Gy</td>
<td>27.7 ± 18.4 Gy</td>
<td>97.9 ± 29.7%</td>
<td>0.92</td>
</tr>
<tr>
<td>Skin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V100</td>
<td>60.6 ± 19.5 cc</td>
<td>115.3 ± 39.7 cc</td>
<td>55.0 ± 17.8%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>D05</td>
<td>65.2 ± 1.2 Gy</td>
<td>68.0 ± 1.7 Gy</td>
<td>95.8 ± 1.8%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Dmean</td>
<td>44.0 ± 4.2 Gy</td>
<td>51.5 ± 4.7 Gy</td>
<td>85.5 ± 5.6%</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*Abbreviations: IMRT = intensity-modulated radiation therapy; 3D-CRT = three dimensional conformal radiotherapy; PTV₁ = the planning target volume for the first phase; D05, D95 = the dose encompassing 5% or 95% of the volume, respectively; V95 = the volume receiving at least 95% of dose; V100 = the volume receiving at least 100% of dose (the prescription dose).*

**Reduction of Volumes receiving 100% dose using IMRT**

- **Femur:** 57%
- **Normal Soft Tissue:** 78%
- **Normal Skin:** 45%
- **Mean Skin Dose:** Decreased by 14%

*Hong et al., IJROBP 2004*
Comparison of intensity-modulated radiotherapy with conventional conformal radiotherapy for postoperative retroperitoneal soft tissue

E. Musat \textsuperscript{a}, G. Kantor \textsuperscript{*a}, J. Caron \textsuperscript{a}, P. Lagarde \textsuperscript{a}, H. Laharie \textsuperscript{a}, E. Stoeckle \textsuperscript{b}, J. Angles \textsuperscript{a}, L. Gilbeau \textsuperscript{a}, B.N. Bui \textsuperscript{c}

\textsuperscript{a} Musat et al., Cancer Radiotherapy 2004

\textsuperscript{IAEA Pediatric Radiation Oncology Training
Dr Laskar Version 1 June 2009
External postoperative radiation therapy for retroperitoneal sarcoma is an example of treatment using large fields for complex shaped volumes of irradiation. Prescribed dose is limited by tolerance of adjacent organs at risk (OAR). From a recent case treated by conventional conformal radiotherapy (3D-CRT), we evaluate the benefit of five theoretical IMRT plans. Criteria used are calculated from DVH related to delineated PTV and OAR. IMRT should permit to enhance the prescribed dose without increasing dose in the OAR (especially residual kidney, spinal cord and small bowel). This theoretical study show the feasibility of a dose escalation from a treatment dose of 45 Gy delivered by 3D-CRT up to a planning dose of 54 Gy calculated by IMRT with:

- for the PTV: an improvement of the dose homogeneity about 5% (range 2–6%) and moreover the coverage factor (CF) about 13% (range 9–16%);
- for the OAR: an improvement of the protection factor (PF) about 20% (range 11–24%);
- and thus an improved conformity index (CI = CF x PF) about 25% (range 15–32%).

Musat et al., Cancer Radiotherapy 2004
3D CRT vs. IMRT vs. PROTONS FOR PELVIC SARCOMA

Fig. 3. Pelvic sarcoma, axial slices: (a) Three-dimensional conformal radiation therapy (3D-CRT); (b) intensity-modulated radiation therapy (IMRT); (c) protons. Isodose lines, 3D-CRT and IMRT: red = 40 Gy; aqua = 30 Gy; purple = 15 Gy; yellow = 5 Gy. Isodose lines, protons: orange/red = 40 Gy; green = 30 Gy; light blue = 15 Gy; dark blue = 5 Gy.

Lee et al, IJROBP 2005
IMRT OF LARGE FIELDS: WHOLE-ABDOMEN IRRADIATION

LINDA HONG, Ph.D.,* KALED ALEKTIAR, M.D.,† CHEN CHUI, Ph.D.,* TOM LOSASSO, Ph.D.,* MARGIE HUNT, M.S.,* SPIRIDON SPIROU, Ph.D.,* JAY YANG, Ph.D.,* HOWARD AMOLS, Ph.D.,* CLIFTON LING, Ph.D.,* ZVI FUKS, M.D.,† AND STEVE LEIBEL, M.D.†

Departments of *Medical Physics and †Radiation Oncology, Memorial Sloan-Kettering Cancer Center, New York, NY

Results: Treatment plan optimization calculations required 20–80 min on a 500-MHz DEC alpha workstation. Including beam splitting, an average of 16 DMLC beams was used per patient. Delivery of 150 cGy required, on average, 1442 monitor units. For the same dose constraints on the kidneys, whole-abdomen IMRT resulted in significant dose reduction to the bones and improved PTV coverage as compared to conventional treatment. For a prescription dose of 30 Gy, the volume of the pelvic bones receiving more than 21 Gy was reduced on average by almost 60% with IMRT, and the mean dose to all bones was reduced from 24.0 ± 1.5 Gy to 18.5 ± 1.0 Gy (p = 0.002). PTV coverage, as measured by V95 (the volume receiving 95% of the prescription dose), improved from 71.7 ± 4.8% with conventional treatment to 83.5 ± 3.9% with IMRT (p = 0.002), although small regions of underdose in areas near the kidneys could not be avoided completely. The high-dose regions within the PTV, as measured by D05 (the dose covering 5% of PTV volume), increased slightly from 31.2 ± 0.6 Gy with conventional treatment to 32.8 ± 0.2 Gy with IMRT.